3. TCM30

TCM30

Introduction

This part gives detailed information about the function and servicing of the TCM30 monitor.

Contents

This chapter contains the following topics.

General Information 3-2
Test Procedures 3-11
Dismantling and Replacements 3-31
Spare Parts List 3-35
Circuit Description 3-39
Input-Output 3-41

General Information

Overview

Introduction This section gives some general information about the TCM30 monitor.

Contents This section contains the following topics.

General Information 3-3

General Information

Introduction

The TCM30 pO_2 monitor is intended for transcutaneous monitoring of pO_2 via a heated electrode mounted on the skin. The measurement data are presented on the LED display

The monitor is fitted with a rechargeable NiCd battery. When fully charged, its capacity correspond to approximately three hours of operation.

A mains adapter charges the NiCd battery and supplies the monitor simultaneously. A discharged NiCd battery is recharged in approximately 16 hours when the monitor is switched on during charging. If not, 8 hours is required for a full recharge.

The serial data or analog outputs are functional only if the monitor is powered from the mains.

If an optional battery cassette is connected to the monitor, its total capacity corresponds to approximately 11 hours of operation.

The TCM30 include the following features:

- 4 channel analog output (pO_2, heat, temperature, alarm)
- Trend memory for up to 12 hours patient data collection

The monitor cabinet is designed for attaching the optional battery cassette to the monitor

Software

The monitor is microcomputer controlled, and the software primarily takes care of the following functions:

- Measurement of the primary electrode parameter and conversion into pO_2 (mmHg or kPa)
- Measurement of the electrode temperature and heat control
- Data transfer to the display and the serial data/analog outputs
- Activation of the acoustic alarm where the pO_2, heat or temperature parameter limits are exceeded
- Front panel keyboard control
- Automatic calibration and electrode check

Continued on next page

General Information, *Continued*

Hardware

The electronics are mounted on four PCBs. Please refer to the block diagram at the end of the TCM30 part.

Analog PCB

This board includes the electrode input circuits, the A/D converters, the patient safety barrier components and the charging circuit for the NiCd battery.

Signals from the electrode and the electrode amplifiers mounted in the electrode plug, that is, the pO_2 and thermistor signals, are converted into pulse signals by the two A/D converters. The pulse duty cycle represents the measured value.

One of the A/D converters is common to all parameters via the input multiplexer. The other is used in order to increase the speed and security of the electrode temperature regulation system.

The electrode temperature is measured by means of a thermistor which is part of a temperature resistor bridge.

The heat power is measured across the resistor R, and the microcomputer is informed via the input multiplexer and A/D converter 1.

The NiCd battery charging circuit adjusts the charging current according to the monitor consumption.

The galvanic separation between the power supply board and the rest of the monitor is achieved by using a switching power supply, and opto-couplers for the input/output signals.

The monitor includes five opto-couplers. Two for the input/output, and two for automatic power supply regulation.

The fifth opto-coupler is transferring on/off information from the on/off switch to a switching circuit, which prevents the optional battery cassette from being discharged, if it is not dismounted after use.

Continued on next page

General Information, *Continued*

Main PCB

Includes the microcomputer system, the parallel and serial input/output ports, the electrode heating supply, the 5 V supply and the LED display control system.

The two parallel ports interface the microcomputer with the analog signals, the front panel keys and the heat control.

A demonstration mode is called by switching on the monitor while pressing the ALARM-OFF key and the ▲ key simultaneously. In this mode, the time out in the set-up and AUX programs, are cancelled for 30 minutes after power on.

To get back to normal, switch off and on the monitor.

Selection between mmHg and kPa, and in-vivo cal, are performed while the monitor is in service mode step 4.

Switch on the monitor while the ALARM-OFF key and the SET key are pressed simultaneously. The software version No. is displayed in the AUX display. Wait until the software No. stops flashing and select step 4 (0:04 in the AUX display) by the ALARM-OFF key.

Now, selection between mmHg and kPa are performed by the ▲ or ▼ keys. The corresponding light-bar "kPa" or "mmHg" will be lit.

Selection between in-vivo cal. and not in-vivo cal. is performed by the CAL key. In-vivo cal. "mode" is indicated by a light-bar at the AUX display.

The UART controls the serial input/output signals for the serial data interface. The output signal is gated with the analog control signal from Port 1.

The heat supply is derived via a D/A converter and a switching power supply. It is controlled by the heat-off signal and the max. temperature monitoring circuit, the so-called "watch-dog" circuit, which disables the heat in the case of a software error.

The Main PCB includes a power supply monitoring system for activating the BAT light-bar or resetting the monitor.

If the monitor is powered from the built-in NiCd battery only, the light-bar is activated via comparator 1, indicating that the function time of the Monitor is limited to approximately three hours on a fully charged battery.

The heat supply circuit has a battery-low terminal which is activated if the NiCd battery voltage drops below 7.0 V. This causes the BAT light bar to flash, indicating that the function time now is limited to approximately 10 minutes.

If the voltage drops below 6.5 V, the microcomputer and its peripherals will be reset.

Continued on next page

General Information, *Continued*

Main PCB *(continued)*

The microcomputer system consists of the 8-bit CMOS processor NSC 800, the EPROM (program memory), the RAM (data memory) and the input/output peripherals already mentioned. The system has a multiplexed bus structure where the low order part of the address bus is shared with the data bus.

The display is multiplexed and the 7-segment display data are latched from the data-bus.

Display PCB

Includes the LED display, the audio transducer for the acoustic alarm, the electrode holder micro-switch and the five front panel keys. If the mains adapter is removed from the monitor, the display light is reduced. This reduces the power consumption and thus prolongs the function time of the monitor.

Power Supply

The circuits of this PCB are galvanic isolated from the rest of the monitor by means of the transformer and opto-couplers on the Analog PCB. It includes a switching regulator power supply system, 3 linear DC regulators and a communication circuit for the analog output and serial data input/output.

The switching regulator has a combined current limiter/battery control circuit which disables the regulator output if the battery voltage decreases below 6.2 volts.

Continued on next page

General Information, *Continued*

Patient Safety

TCM30 is designed to comply with the IEC safety standards for medical equipment.

Any external device connected to the monitor, such as mains adapters, recorders, computers etc., are galvanic isolated from the patient circuits.

The isolation is achieved by means of opto-couplers and a switching transformer.

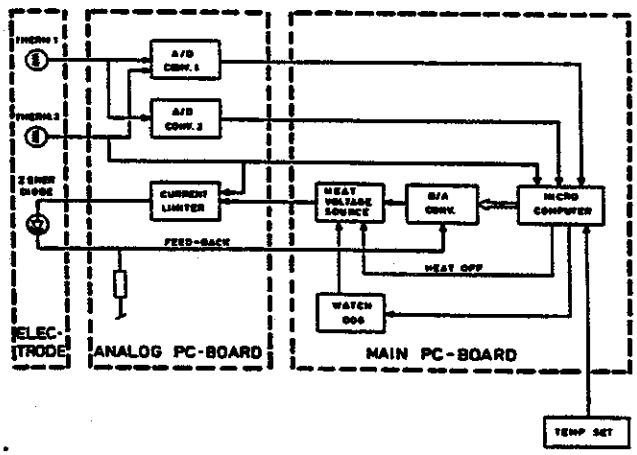
The "patient-side" of this barrier thus includes the Analog PCB, the Main PCB, the Display PCB and the NiCd battery.

Each individual monitor is exposed to a final safety test before it leaves RADIOMETER for shipment.

This safety test includes a patient barrier isolation test by a high voltage generator, and a leakage current test.

The monitors are fitted with a comprehensive safety system to minimise the probability of loosing electrode heat control.

- The electrode power consumption is continuously monitored. If it exceeds 600 mW for more than two minutes, the heating will be switched off and Error 5 will be displayed.
- If the electrode temperature increases to more than 45.6 °C, the heating will be switched off, and Error 10 is displayed. Further, the heat regulator will be disabled.
- If a temperature difference of more than 0.6 °C is detected between the two thermistors (E5250) the heating will be switched off and Error 11 is displayed.
- If a software error occurs, a monitoring circuit, the so-called "watchdog" circuit, on the Main PCB will switch off the heating.



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General Information, *Continued*

Specifications

Environmental Requirements

Ambient temperature: 5 - 40 °C. *)

Relative humidity: 20 - 80 %.

*) If the electrode temperature is below 15 °C before calibration, the monitor might signal Error 1, indicating that the electrode did not reach the pre-set temperature within 3 minutes.

Calibrate then the monitor in two steps:

Calibrate with the temperature pre set to 37 °C. Repeat the calibration with the temperature pre set to the actual monitoring temperature.

Ventilation Requirements

The system must be situated in a well ventilated, dust free atmosphere.

Dimensions

Height (cm) 8

Width (cm) 24

Depth (cm) 26

Weight (kg) 2.7

Units

The monitor can be set-up so as to indicate the O_2 tension in either mmHg or kPa directly.

Monitor Battery

Rechargeable NiCd battery. The duty period is 3 hours per charge, typically, at 25 °C.

The recharging time is approximately 8 hours at 25 °C, via the mains adapter.

Monitor pO_2 channel

Range: 0 - 2000 mmHg or 0 - 266.7 kPa

Accuracy: Better than ± 2 mmHg/0.2 kPa ± 0.1 % of reading at 25 °C.

Polarisation Voltage: -680 mV

Continued on next page

General Information, *Continued*

Specifications ***(continued)***

Temperature Settings

37.0 °C, 41.0 °C, 41.5 °C, 42.0 °C, 42.5 °C, 43.0 °C, 43.5 °C, 44.0 °C, 44.5 °C, 45.0 °C.

Accuracy: Better than ± 0.1 °C excluding sensor.

Alarms

Audio visual. The acoustic alarm will be activated after a delay of 5 seconds when an alarm state has occurred.

pO_2 alarm limits: (selected by user)	LOW: 0 - 800 mmHg/0 - 106.7 kPa HIGH: 0 - 2000 mmHg/0 - 266.7 kPa
Temperature:	± 0.3 °C deviation from pre-set value will cause alarm.
Battery low:	Alarm goes on before the battery is empty

Leakage Currents

Enclosure Leakage Current:	Max. 100 uA
Patient Leakage Current:	Max. 10 uA

Serial data output

Signal	Connector Pin
TX data	11
RX data (normally not used)	14
Common Return	15

Transfer parameters

2400 baud

8 bits/character

Even parity

2 stop bits

Continued on next page

General Information, *Continued*

Specifications *(continued)*

Analog outputs

Channel/ Connector	Parameter	Output
1 / pin 9	pO_2	5 mV/mmHg (40 mV/kPa) or 0.5 mV/mmHg (4 mV/kPa) (selected in the AUX program 200/2000 mmHg or 25.0/250.0 kPa)
2 / pin 10	Heat	1mV/mW, range 0-650 mW
3 / pin 8	Temperature	50 mV/°C, range 30 °C to 50 °C. Examples: 30 °C gives an output of 0 mV. 43 °C gives an output of 650 mV
4 / pin 5	Alarm	Acoustic alarm activated: 1000 mV Acoustic alarm not activated: 0 mV Max. source current: 1 mA
-- / pin 15	Common return	

Test Procedures

Overview

Introduction

This section details the procedures for testing and adjusting the TCM30 monitor. For each of the paragraphs the required tools for testing are listed.

Contents

This section contains the following topics.

Introduction 3-12
Checkout and Adjustment 3-13
Monitor Performance Check 3-21
Electrode Performance Check 3-24
Error Codes 3-28

Introduction

Checkout and Adjustment

This Section describes the necessary procedures for checking and adjusting the TCM30.

Yearly Maintenance

RADIOMETER recommends a yearly preventive maintenance checkout which includes:

Checkout and Adjustment.

Monitor Performance Check.

These procedures are outlined in the following two paragraphs.

Repairs

Repairs to TCM30 are made only by replacing defective PCBs, which are returned to RADIOMETER for exchange. This is to ensure patient and functional safety.

Checkout and Adjustment

Introduction

To carry out the checkout and adjustment procedure, the following accessories are necessary:

- TC-Electrode Simulator, code 901-705 as described in Chapter 6 of the Service Manual, ACCESSORIES.
- 4 1/2 digit Digital Voltmeter, (the Fluke 8060A or similar is recommended). Please note that checkout and adjustment of the 5 V reference voltage require a 5 1/2 digit instrument.
- Electrode Control Cable for TC Electrode Simulator. Code 617-854.
- Output Control Cable for TC Electrode Simulator. Code 617-855.
- Variable Power Supply, 0 - 12 VDC, 1 A.
- Adjustment tool for the trimming potentiometers.

The Checkout and Adjustment procedure is based on the test software included in the monitor.

The test program is called by switching on the monitor while the electrode simulator is connected to the monitor with the ELECTRODE switch set in the TEST position.

Without the simulator, the test program can be called by switching on the monitor while pressing the ALARM OFF and SET keys simultaneously.

The test software includes 20 program steps. The actual test mode number is displayed in the AUX display (except steps 1 and 5).

The pO_2 display functions as a Digital Voltmeter in step 8 - 10.

The ALARM OFF key is used to step through the test program. The stepping direction can be reversed with the SET key (except in step 2).

Before the checkout and adjustment procedure is started, the internal NiCd battery should be well charged.

Self-test

This procedure checks the RAM, EPROM, and peripherals.

Step	Action
1.	Connect the TC Electrode Simulator to the monitor with the two control cables.
2.	Set the simulator ELECTRODE switch to TEST and switch on the monitor. All display segments, light-bars and the audio alarm will be activated for 2 seconds. The AUX display will show the software version number (the first 10 seconds flashing).
3.	Press the ALARM OFF key to advance the test program.

Continued on next page

Checkout and Adjustment, *Continued*

Display PCB

Step 0:02

The following steps are carried out to check the keys and display segments.

Step	Action
1.	Press the SET key. The AUX display and its light-bars will be activated.
2.	Press the ▲ key. The left part pO_2 display and its light-bars will be activated.
3.	Press the CAL key. The right part pO_2 display and its light-bars will be activated.
3.	Press the ▼ key. The audio alarm steps through all levels.

Step 0:03

The following steps are carried out to check the electrode holder micro-switch and the reading of the electrode code.

Step	Action	
1.	Electrode holder micro-switch out:	111 in right part of pO_2 display.
	Electrode holder micro-switch in:	000 in right part of pO_2 display.
2.	Simulator ELECTRODE switch pos.	left part of pO_2 display
	pO_2/pCO_2	111
	pCO_2	000
	pO_2	111
	TEST	000

In-vivo cal. /mmHg - kPa

Step 0:04

These steps are carried out to check that the in-vivo cal. and mmHg-kPa selections are possible.

Step	Action
1.	Switch between mmHg and kPa by the ▲ or ▼ key. The light bar for the selected unit will be lit (decimal point also lit for kPa).
2.	Switch between in-vivo cal and not in-vivo cal by the Cal key. A light bar by the AUX display indicates in-vivo cal.
3.	Ensure that the monitor settings are correct before continuing with the next step.

Please observe that in-vivo cal. is not approved by the FDA in the USA.

Continued on next page

Checkout and Adjustment, *Continued*

Power Supply

The following procedures are carried out to check the Power Supply.

The procedures require the cabinet to be opened.

	Step	Action
Step 0:05	1.	Entire display is lit ("0.05" is not shown in AUX display). Connect 12 VDC (external power supply) to the simulator terminal DC INPUT. Check that the secondary voltage of the switching transformer is 8.20 ± 0.15 V (DVM+ to TP7, DVM- to TP4 on the Analog PCB).
Step 0:06	2.	pO_2 display is off. Disconnect the external power supply from the simulator. Connect the monitor to the mains by means of the Mains Adapter.
	3.	Check the above voltage for 9.20 ± 0.2 V.
Step 0:07	4.	pO_2 display is off. Connect DVM+ to TP5 and DVM- to TP4 on the Analog PCB and check that the voltage is 5.000 ± 0.003 V (+5V). If outside, adjust R53 on the Main PCB for 5.000 ± 0.001 V.
	5.	Connect DVM+ to TP 8 and DVM- to TP 4 on the Main PCB and check that the voltage is 5.00 ± 0.1 V (+ 5V RAM).

pO_2 Channel

This procedure checks the polarisation voltage and zero-point for the pO_2 channel.

	Step	Action
Step 0:09	1.	Check that the polarisation voltage reading in the pO_2 display is between 0.6750 and 0.6850 (-675.0 to -685.0 mV).
Step 0:08	2.	Connect the simulator TEST SOURCE -680 mV terminal to the TEST INPUT pO_2 terminal and check that the pO_2 display shows the same value as for the polarisation voltage ± 0.5 mV (Step 0:09).

In step 0:10 the display shows the voltage applied to the TEST INPUT pO_2 terminal minus the polarisation voltage obtained in step 0:09. This facility is, however, not used in the checkout and adjustment procedures.

Continued on next page

Checkout and Adjustment, *Continued*

Temperature Channel 1

This procedure checks the zero-point and gain for the temperature channel 1.

The procedures require the cabinet to be opened.

	Step	Action
Step 0:12	1.	Set the simulator TEMPERATURE switch to 37 °C and the THERMISTOR switch to SINGLE .
		Check that the display shows 36.985 and 37.015 (zero-point).
		If outside, adjust R17 on the Analog PCB to a reading between 36.997 and 37.003.
	2.	Set the simulator TEMPERATURE switch to 45 °C.
		Check that the display reading is between 44.985 and 45.015 (gain).
		If outside, adjust R20 on the Analog PCB to a reading between 44.995 and 45.005.
		Readjust R17 and R20.
Step 0:14	3.	Set the simulator TEMPERATURE switch to 37 °C.
		Check that the display reading is between 36.900 and 37.100.
	4.	Set the simulator TEMPERATURE switch to 45 °C.
		Check that the display reading is between 44.900 and 45.100 (thermistor 1 via the MUX).

If the readings in step 0:14 are not within the stated ranges, repeat the adjustments in step 0:12 and repeat the checks in step 0:14.

If the readings in step 0:14 are still outside the range, the Analog PCB is defective and must be replaced.

Continued on next page

Checkout and Adjustment, *Continued*

Temperature Channel 2

This procedure checks the zero-point and gain for the temperature channel 2.

The procedures require the cabinet to be opened.

	Step	Action
Step 0:13	1.	Set the simulator THERMISTOR switch to DOUBLE.
	2.	Set the simulator TEMPERATURE switch to 45 °C. Check that the display shows 44.965 and 45.035 (zero-point). If outside, adjust R26 on the Analog PCB to a reading between 44.995 and 45.005.
	3.	Set the simulator TEMPERATURE switch to 37 °C. Check that the display reading is between 36.965 and 37.035 (gain). If outside, replace the Analog PCB.

Heat Regulator

This procedure checks the regulator for heating the electrode.

	Step	Action
Step 0:15	1.	pO_2 display is off. Set the simulator THERMISTOR switch to DOUBLE and the TEMPERATURE 37 °C.
	2.	Connect the DVM+ to simulator HEAT- and DVM- to HEAT+ and check that the voltage is between -11.8 and -14.2 V (electrode voltage, max. heat).
	3.	Move the DVM+ to simulator GND and check that the voltage is 1.00 V +/- 0.05 V (electrode current, max. heat).
	4.	Set the simulator TEMPERATURE to 45 °C and check that the voltage is less than 0.05 V (electrode current, min. heat).
	5.	Set the simulator TEMPERATURE to 46 °C and check that the voltage is less than 50 mV (max. temp.).

If the DVM readings in step 0:15 are not within the stated tolerances, check the heat supply circuit on the Main and Analog PCBs, and replace the defective board.

Continued on next page

Checkout and Adjustment, *Continued*

Analog Outputs

This procedure is carried out for checking the analog outputs.

The procedures require the cabinet to be opened.

Connect the monitor to the mains via the Mains Adapter. Set the Simulator OUTPUT switch to ANALOG.

Allow in each step the analog output to stabilise (approximately 30 seconds) before reading the DVM.

Please note that the heat output is obtained on the "pCO_2" connector on the Electrode Simulator.

The pO_2 display is off during these steps.

	Step	Action
Step 0:16	1.	All channels, 0% modulation Check that the output from all 4 channels (pO_2, heat, temp., and alarm) are -109.0 ± 5.0 mV. If outside, adjust the pO_2 channel (by R48 on the Power Supply PCB) to -109.0 ± 1.0 mV. Check that the other 3 channels are -109.0 ± 5.0 mV.
Step 0:17	2.	All channels, 20.12% modulation Check that the output from all 4 channels (pO_2, heat, temp., and alarm) are 1000.0 ± 15.0 mV. If outside, adjust the pO_2 channel by R67 on the Power Supply PCB to 1000.0 ± 1.0 mV. Check that the other 3 channels are 1000.0 ± 15.0 mV.
Step 0:18	3.	All channels, 1.95% modulation Check that the output from all 4 channels (pO_2, heat, temp., and alarm) are 0.0 ± 5.0 mV.

If the tolerances in step 0:16, 0:17, or 0:18 are exceeded after the above adjustments have been performed, the Power Supply PCB is defective and must be replaced.

Continued on next page

Checkout and Adjustment, *Continued*

Max. Temp. Watchdog

This procedure checks the Max. Temp. Watchdog. In this step the CPU does not trigger the watchdog for which reason the heat is turned off.

Step 0:19

The pO_2 display is off during this step.

Step	Action
1.	Simulator TEMPERATURE 37 °C. Connect DVM- to simulator HEAT+ and DVM+ to GND. Check that the voltage is less than 0.050 V.

Serial Data

This procedure checks the serial output via a loop-back test.

Step	Action
Step 0:19 1.	Select SERIAL LOOP BACK on the simulator OUTPUT switch. Check that the centre bar of the display segments step continuously across the display. Disconnect the mains adapter and check that the display shows "ErrErr".

NiCd Battery

The pO_2 display shows "888888" during these steps.

The procedures require the cabinet to be opened.

Step	Action
Step 0:20 1.	Load = 750 mA Ensure that the monitor is <u>not</u> supplied from the mains adapter (supplied from the NiCd battery only). Connect the DVM to the NiCd battery terminals. Check that the voltage is above 7.5 V (fully charged battery).
2.	+ 5 V Connect DVM+ to TP3 and DVM- to TP4 on the Main PCB. Check that the voltage is 5.000 ± 0.005 V.
3.	+ 5 V RAM Switch off the monitor. Connect DVM+ to TP 8 and DVM- to TP 4 on the Main PCB. Check that the voltage is above 3.0 V.

Continued on next page

Checkout and Adjustment, *Continued*

Bat Light Bar

The following test/adjustment is performed while the monitor is in normal monitoring mode (Simulator ELECTRODE switch not in pos. TEST.).

The procedures require the cabinet to be opened.

Step	Action
1.	Ensure that the mains adapter is not connected to the Monitor.
2.	Connect a variable power supply to the monitor's internal battery leads instead of the NiCd battery. Adjust the power supply to 9 volts and switch on the monitor.
3.	Reduce slowly the power supply voltage until the BAT light bar begins to flash. Check using a DVM that the power supply voltage is 7.20 ± 0.1 V. If outside, adjust the potentiometer R51 on the Main PCB. Hint: If the "BAT low" activation voltage is above 7.30 V, turn the potentiometer counter-clockwise. If it is below 7.10 V, turn the potentiometer clockwise.
4.	Repeat steps 2 and 3.
5.	Remove the power supply and the DVM and reconnect the NiCd battery.
6.	Reprogram the Setup and AUX programs.
7.	Check the mmHg/kPa and in-vivo cal. settings in the service program, step 0:04.

Monitor Performance Check

Introduction

The System Performance Check procedure is intended for the monitor and its accessories without the need of any measuring instruments or tools. The check is recommended before installation.

The Performance Check procedure makes use of the built-in test program which is called by switching on the TCM30 while the ALARM OFF and SET keys are activated simultaneously.

The ALARM OFF key is used to step through the test program. The direction of the stepping can be reversed by the SET key.

The actual "Step-number" is displayed in the AUX display (except steps 1 and 5).

Ensure that the internal battery is fully charged before starting the performance check.

Setup Program

The following steps are carried out to check the Setup program.

Step	Action
1.	Supply TCM30 from the mains by the Mains Adapter.
2.	Connect an electrode to the Monitor and switch on. All display segments, light-bars and the audio alarm are activated for a short period. The CAL light-bar flashes, calling for a calibration.
3.	Press the SET key to call the Setup program and check it in accordance with the Operator's Manual.

AUX Program

The following is carried out to check the AUX program.

Step	Action
1.	Press the ▲ and ▼ keys simultaneously for 3 seconds to call the AUX program. Check it according to the Operator's Manual.

Calibration

The following steps are carried out to check the calibration.

Step	Action
1.	Press the CAL key and perform a calibration according to Operator's Manual.
2.	Switch off the Monitor.

Continued on next page

Monitor Performance Check, *Continued*

Analog Outputs

The following steps are carried out to check the analog outputs.

Step	Action
1.	Connect an analog recorder to the 15 pole "D "connector by the analog cable 617-851 and switch on the Monitor.
2.	Re-calibrate and check that the pO_2 analog output is in accordance with the data displayed on the monitor.
3.	Switch off the Monitor.

Self-Test

The following steps are carried out to check that the internal self-test runs correctly.

Step	Action
1.	Switch on the TCM30 while the ALARM OFF and SET keys are activated simultaneously. All display segments, light-bars and the audio alarm will be activated for a short period. The AUX display is showing the software version number (the first 10 seconds flashing).
2.	Press the ALARM OFF key to advance the test program.

Continued on next page

Monitor Performance Check, *Continued*

Keys and Display Segments

Step 0:02

The following steps are carried out to check the keys and display segments.

Step	Action
1.	Press the SET key. The AUX display and its light-bars will be activated.
2.	Press the ▲ key. The left part of the pO_2 display and its light-bars will be activated.
3.	Press the CAL key. The right part of the pO_2 display and its light-bars will be activated.
4.	Press the ▼ key. The audio alarm steps through all levels.

In-vivo cal. /mmHg - kPa

Step 0:04

These steps are carried out to check that the in-vivo cal. and mmHg-kPa selections are possible.

Step	Action
1.	Switch between mmHg and kPa by the ▲ or ▼ key. The light bar for the selected unit will be lit (the decimal point is lit when kPa is selected).
2.	Switch between in-vivo cal and not in-vivo cal by the Cal key. The light-bar at the AUX display indicates in-vivo cal.
3.	Ensure that the monitor settings are correct before continuing with the next step.

Power Supply

Step 0:20

Disconnect the mains adapter and check that the display light level decreases.

Electrode Performance Check

Introduction

This procedure is intended for the following electrode: E5250 (pO_2).

In case of malfunction it is recommended to check the electrode according to the instructions below.

The following instruments and accessories are required (and assumed to be OK):

TCM30 monitor

TCC3 or A7450 calibration unit

CAL1 gas (green) (5% CO_2, 20.9% O_2), part no. 962-107

CAL2 gas (blue) (10% CO_2, 0% O_2), part no. 962-098

Accessory kit, i.e.

D826, part no. 904-308

Before the performance check it is recommended to remembrane the electrode unless you want to check an error diagnosis. If so, it is recommended to test the electrode twice. First with the original membrane, secondly, with a new membrane.

If the old membrane has been mounted on the electrode for a long time and the electrolyte has dried out, the electrode should be cleaned with distilled water and rubbed thoroughly with the cleaning paper. ***Never use emery paper or similar.***

Continued on next page

Electrode Performance Check, *Continued*

Heating, Signal Range and Stability

These checks are performed during a normal calibration procedure.

Refer to the standard procedure as described in the Operator's Manual. Set the temperature to 45 °C. Use the Green calibration gas.

Heating

The preset temperature (± 0.05 °C) must be reached within three minutes. If not, ERROR 1 will be flashing in the AUX display and an acoustic beep will be heard. This error may be provoked if the ambient temperature is below the specified minimum temperature of 15 °C.

If the electrode temperature sensing system is defective, i.e. the temperature sensors or their connections, ERROR 10 or 11 (displayed in the pO_2 display + continuous acoustic alarm for five seconds) may be called. However, these errors are normally caused by a defective or mis-aligned monitor.

Signal Range

The electrode signal must be within the specified range, see below, within one minute after the electrode has reached the preset temperature. If not, ERROR 2 will be flashing in the AUX display and an acoustic beep will be heard. The signal range check is finished when the pO_2 value is displayed.

Monitor pO_2 range is: -1.9 * *B* * 0.209 to -0.5 * *B* * 0.209

(-302.1 to -79.5 mV at B = 760 mmHg).

The electrode voltage may be viewed using the service program (step 0:10).

Signal Stability

After heating and range check the stability is checked. The average drift must be less or equal to 1% per minute within 15 minutes after the SIGNAL RANGE CHECK. If the drift is greater, ERROR 3 will be flashing in the AUX display and an acoustic beep will be heard. The SIGNAL STABILITY CHECK is finished when the green READY LED is activated and an acoustic double-beep is heard.

Continued on next page

Electrode Performance Check, *Continued*

pO_2 Zero Point and Sensitivity

These checks are carried out using the service program.

Insert the electrode in the holder and select test mode step 10. Press the ▲ key to start electrode heating. Supply green cal1 gas (20.9% O_2) to the electrode holder. Wait 10 minutes for the signal to stabilize and read the signal (which is displayed as 0.xxxx V).

Change the gas supply to the blue cal2 gas (0% O_2) and read the electrode signal after 10 minutes.

Zero point: Check that the relative zero point, calculated as the relationship between the electrode signal for the blue gas and the green gas, is less than 0.04. The relative zero point is calculated as follows (B is the actual barometric pressure):

$$Zero point(rel.) = \frac{Vgas2 * B}{Vgas1 * 760}$$

Sensitivity: Check that Vgas1 is between:

$$mV(\min) = \frac{79.5 * B}{760} \quad \text{and} \quad mV(\max) = \frac{302.1 * B}{760}$$

corresponding to a sensitivity between 0.5 mV/mmHg and 1.9 mV/mmHg [1].

Please note that a too high sensitivity may be caused by silver deposits on the platinum cathode. The sensitivity may be reduced by remembraning and rubbing the electrode surface carefully with the cleaning paper. **Never use emery paper or similar!**

The sensitivity is calculated as follows:

$$S(mV / mmHg) = \frac{Vgas1}{O2 pressure gas1} = \frac{Vgas1}{B * 0.209}$$

1) Normally, the pO_2 sensitivity is expressed in pA/mmHg, but system converts the current to an equivalent voltage; 10 pA corresponds to 1 mV.

Continued on next page

Electrode Performance Check, *Continued*

TCM30 Electrode Performance Check Results

Document the check results in the table below and file a copy for future reference. Accept criteria are shown in brackets for each parameter.

Step	Result		
Heating	Error displayed:		(None)
Signal Range	Error displayed:		(None)
Signal Stability	Error displayed:		(None)
pO_2 Zero Point	Barometric pressure =	mmHg	
	Vgas1 =	mV	
	Vgas2 =	mV	
	Zero point(rel) =	mV	(<0.04)
pO_2 Sensitivity	Vgas1 (min) =	mV	
	Vgas1 (max) =	mV	
	Vgas1 within limits?		(Yes)
Overall Evaluation			(All above criteria fullfilled)
Engineer			
Date (YYYY.MM.DD)			

Error Codes

Introduction

The error codes are divided into two categories. "Soft Errors" are displayed in the AUX display (flashing) and an acoustic beep is heard. "Hard Errors" are displayed in the pO_2 display accompanied by a continuous acoustic alarm for five seconds.

Soft Errors are numbered from 0 to 5 and are caused by incorrect operation or defective accessories, e.g. electrodes or electrode membranes.

Hard Errors are numbered from 10 to 16 and are normally related to electronic disturbances or a defective Monitor. However, Error 10 and 11 may be caused by a defective electrode (temperature sensors).

Soft Errors

The table lists the error codes as well as the possible causes and Service actions.

Error Code	Cause	Service Action
0	RAM has lost its content due to, e.g.; the internal battery is completely exhausted or disconnected	Check setting in service program, step 4 (mmHg/kPa and in-vivo cal.) Reprogram the Setup and AUX programs and recalibrate.
1	The electrode has not reached the preset temp. within 3 minutes during calibration.	Recalibrate. If error persists, replace the electrode.
	Defective electrode	Replace the electrode.
2	Electrode signal range not acceptable.	Recalibrate. Remembrane and then recalibrate.
	Incorrect preset calibration value.	Check the value and recalibrate.
	The membrane has not been changed regularly.	Remembrane and then recalibrate.
	Unsuccessful membraning.	Remembrane.
	Poor supply of calibration gas.	Check the gas source and connection.
	Defective electrode.	Replace the electrode.
3	Electrode stability not acceptable.	Recalibrate. Remembrane and then recalibrate.
	Membrane has not been changed regularly.	Remembrane and recalibrate.
	Unsuccessful membraning.	Remembrane.
	Poor supply of calibration gas.	Check the gas source and connection.
	Defective electrode.	Replace the electrode.

Continued on next page

Error Codes, *Continued*

Soft Errors ***(continued)***

Error Code	Cause	Service Action
5	The electrode power dissipation has exceeded 650 mW for more than 2 minutes due to too low ambient temperature.	Raise the ambient temperature and recalibrate.
	Defective electrode.	Replace the electrode.

Hard Errors

The table lists the error codes as well as the possible causes and Service actions.

Error Code	Cause	Service Action
10	Temperature error. Either higher than 45.6 °C or lower than 5 °C	Change the electrode. If the electrode is OK, checkout and adjust the monitor.
11	Temperature difference between the two exceeds 0.6 °C	Same as for error 10
12	Parity error	Reset the microcomputer by switching off and on the monitor. if the error persists, replace the Main PCB
13	Microcomputer hardware error	Checkout and adjust the monitor. If the error persists, replace the Main PCB
14	EPROM checksum error	Same as for error 12
15	Software error	Same as for error 12
16	Software deadlock	Same as for error 12

Dismantling and Replacements

Overview

Introduction This section details the procedures for dismantling the monitors and replacing parts.

Contents This section contains the following topics.

Procedures 3-32

Procedures

Introduction

To dismantle and replace the various parts of the TCM30, the following tools are necessary:

Screwdriver 6 x 1 mm

Pozidrive screwdriver, # 0

Pozidrive screwdriver, # 1

Wrench for the 6 mm hexagonal stand-offs

The numbers in brackets refer to the exploded view in Section 4.

Cabinet (9)

Disconnect all accessories, and switch off the Monitor.

Step	Action
1.	Turn the monitor upside down and remove the 4 bottom screws (11) through the Short form holes, and then carefully lift-off the bottom cover.
2.	When replacing it, ensure that the front and rear grooves latch into the Front Plate (1)/Display PCB (5) and the Rear Plate (19)/Power Supply PCB (15), respectively. See that the 8 felt pads are in place. Be sure that no leads become clamped, and that the top and bottom covers fit together completely before tightening the screws.

NiCd Battery (30)

Step	Action
1.	Disconnect the two battery leads.
2.	Unscrew the four screws securing the battery to the bottom cover and remove the unit.
3.	When the battery is disconnected from the monitor, the RAM memory looses its data information. When the monitor is switched on again after the replacement, Error 0 will be displayed. Reprogram the Setup and AUX programs.

Continued on next page

Procedures, *Continued*

Analog PCB (24)

Step	Action
1.	Unscrew the three screws securing the PCB to the stand-offs (25).
2.	Disconnect the two power supply amphenol connectors, lift the on/off switch and the electrode plug from their grooves and turn the Analog PCB.
3.	Remove the aluminium screen (26) from the five Main PCB stand-offs (27) and disconnect the flat-cable connector from the Main PCB.
4.	Disconnect the on/off switch (16) and the 3-pole display cable. Note the orientation of the electrode plug in the slot of the top cover and the on/off switch cable on the side near the Main PCB.

Main PCB (28)

Step	Action
1.	Disconnect the flat-cable connector next to the Display PCB.
2.	Unscrew the four stand-offs and the two screws securing the PCB and screen to the cabinet.
3.	Separate the PCB from the screen by removing the five remaining screws.

Power Supply PCB and Rear Plate (15) and (19)

Step	Action
1.	Disconnect the power supply cable (17) and lift the PCB and the rear plate out of their grooves and then separate them.
2.	When reassembling, ensure that the cables are not clamped and that the connector slot (17) is directed towards the rear plate edge.

Spare Parts List

Overview

Introduction This section lists the spare parts available for servicing the TCM30 monitor. The spare parts list specifies to which extend the monitor may be serviced as only the spare parts listed may be replaced.

Contents This section contains the following topics.

Introduction 3-36
TCM30 3-37

Introduction

Introduction

All spare parts available for the TCM30 are listed in this section which also includes an exploded view to ease the identification of the parts.

When ordering spare parts include the part number and the description of the part.

Trade-in Parts

The Modules marked with an * must be returned to RADIOMETER for replacement. This is to ensure the highest possible degree of patient and functional safety.

They will be replaced in accordance with our Trade-in arrangement for Modules, with the exception of modules that have been damaged during attempted repairs.

TCM30

Parts Available The numbers in the left column refer to the exploded view at the end of this Section.

Ref. No.	Part No.	Quantity		Description
1	978-788	1		Front Plate, English
	978-791	1		Front Plate, German
	978-795	1		Front Plate, French,
2	940-542	1		Electrode Holder, complete
4	923-278	1		Spacer for Electrode Holder
5	902-470	1	*	Display PCB, complete
6	540-047	1		Micro-switch, complete w. cable
7	826-239	1		Bracket for micro-switch
8	884-864	1		Retaining Plate f. micro-switch
9	886-446	1		Cabinet, blue, complete
10	989-248	1		Short Form Instruction, English
	989-249	1		Short Form Instruction, German
	989-250	1		Short Form Instruction, French
11	001-440	4		Screw, M4 x 40
12	042-410	4		Washer
13	927-031	2		Bottom Rail, complete
14	837-133	4		Rubber foot, self adhesive
15	901-832	1	*	Power Supply PCB, complete incl. Fuse
16	551-175	1		On/off switch, complete w. cable
19	978-524	1		Rear Plate
24	902-428	1	*	Analog PCB, complete with screen
26	885-816	1		Screen
27	039-792	5		Stand-off for Main PCB
28	902-491	1	*	Main PCB, complete
29	885-817	1		Screen for Main PCB
30	431-010	1		NiCd Battery Unit, incl. Fuse (as the unit is also used for the TCM3 a compatibility "kit" for TCM3 below RUN 22 is included)

Continued on next page

TCM30, *Continued*

Parts Available *(continued)*	Ref. No.	Part No.	Quantity	Description
		431-012	6	NiCd Cell
	31	450-031	1	Fuse for NiCd Battery Unit
	32	002-914	1	Screw for Electrode Holder, M3 x 9.4
	33	835-398	1	O-ring
	34	066-412	1	Bushing
	35	008-110	2	Screw, M2 x 10
	36	042-207	2	Washer
	37	008-306	12	Screw, M3 x 6
	38	046-901	13	Spring Washer
	41	010-308	6	Hex Head Screw, M3 x 10 (2.5 mm tool)
	42	046-405	6	Washer
	43	008-308	9	Screw, M3 x 8
	46	043-106	4	Washer
	47	886-239	2	Bracket for Accessory Hinge
	48	923-163	2	Accessory Hinge
	49	009-310	2	Screw, M3 x 10, countersunk
	50	008-316	2	Screw,M3 x 16
	51	008-325	3	Screw, M3 x 25
	52	031-302	1	Nut, M3
	53	885-784	1	Bottom Plate, blue
	54	993-063	1	Insulating Foil
	55	901-831	1	Output PCB, complete with Nylon stand-offs and insulating foil
	56	450-131	1	Fuse for 901-832

Circuit Description

Overview

Introduction

Most of the electronics in the TCM30 is identical to that of the TCM3.

For this reason the description is included in the chapter concerning the TCM3 only. Please refer to Chapter 2, Section 5, "Circuit Description".

Contents

No subtopics.

Input-Output

Overview

Introduction This section details the input and output facilities of the TCM30 monitor.

Contents This section contains the following topics.

Introduction 3-42
Analog Output 3-43
Serial Output 3-44
Serial Input 3-51
Monitor State Diagram 3-52

Introduction

Introduction

The monitor communicates with external equipment such as printers, analog recorders or personal computers via the 15 pole "D" connector on the rear plate. Two output alternatives are provided. Either analog outputs for pO_2, heat, temperature and alarm, or digital output for serial data such as pO_2, heat, temperature, calibration values etc. For test purposes a digital input channel is included. The serial data input-outputs are in accordance with the RS-232-C standard concerning the voltage deviations.

The input-outputs described in this section are active only when the Monitor is powered from the mains or via the rear panel connector terminal 6.

Analog Output

Description

The analog output alternative is selected by short circuiting terminal 15 and 13 on the rear panel connector before switching on the monitor.

The analog output is only active in case the monitor is supplied from the mains.

A 4-channel recording cable is available. It is fitted with a 15-pole female D-connector at one end, and 5 banana plugs at the other. Its length is 2 m and the code number is 617-851. The "D" connector includes a strap between pin 13 and 15, selecting automatically analog output. The analog cable is coded as follows:

Colour / Connector	Signal	Remarks
Green / pin 9	pO_2	5 mV/mmHg (40 mV/kPa) or 0.5 mV/mmHg (4 mV/kPa) selected in the AUX program.
Yellow / pin 10	Heat	1mV/mW, range 0-650 mW
Red / pin 8	Temperature	50 mV/°C in the range 30 °C to 50 °C. Examples: 30 °C gives an output of 0 mV. 43 °C gives an output of 650 mV
Blue / pin 5	Alarm	Acoustic alarm activated: +1000mV. Acoustic alarm not activated: 0mV. Max. source current 1 mA.
Black / pin 15	Common return	

Serial Output

Introduction

The transmission parameters are:

2400 Baud

8 bits/character

Even parity

2 stop bit

The output data consists of ASCII characters: Upper case letters, numerals 0 to 9, decimal points, and line terminators <LF>, <CR> and <NUL>.

The data are organised in data-lines divided into 4 categories:

A Measurement Data and dummy lines

B Continuous Status Messages

C Events

D Trend memory dump

Any line is initiated by a 2-letter line-ID followed by a number of 2-letter field-IDs with possible numerals specifying the parameter value.

Category A

These lines are transmitted every 1.966 seconds when the monitor is in state 1, 2, 3, or 4 (see the state diagram in the paragraph; "Serial Input"), and when trend memory data are viewed as well as during X_{OFF} during trend memory dumping, dummy lines (DU) are transmitted.

Measurement Data (DA package)

Line ID: *DA*

Field IDs:	MO	Measured pO_2	(XXXX.Y) mmHg/(XXX.YY) kPa
	TE	Temperature	(XX.Y) °C
	MW	Heating power	(XXX) mW
	TI	Site timer	(XX.YY) hours.minutes

Before stability checks during calibrations, the field MO is omitted. The field TI is only included when the site timer is active, i.e. during state 8, Measure, state 9, In-vivo Measure, and state 11 and 11a, Prepare In-vivo Measure.

Dummy Lines (DU Package)

Line ID: *DU*

Field ID: DU

Dummy lines are transmitted instead of measurement data during the Starting, Waiting and Sleep states and when viewing trend memory data and during X_{OFF} when dumping trend memory data.

Continued on next page

Serial Output, *Continued*

Category B

This category consists of three types of lines (four in case an in-vivo calibration has been carried out). The lines are transmitted in cycles, one after each line of measured data. Category B lines are not transmitted after dummy lines.

Setup Program (XS Package)

Line ID. *XS*

Field ID:	HO	pO_2 high limit	(XXXX) mmHg/(XXX.Y) kPa
	LO	pO_2 low limit	(XXXX) mmHg/(XXX.Y) kPa
	TI	Site timer (Setup)	(XX.YY) hours.minutes
	TE	Temperature (Setup)	(XX.Y) °C
	CO	pO_2 calibration value	(XXXX) mmHg/(XXX.Y) kPa

AUX Program (XF Package)

Line ID. *XF*

Field ID:	DM	Site timer display mode (X)	1 = site timer
			2 = heating power
			3 = temperature
	TR	Trend indication (X)	0 = off, 1 = on
	AV	Alarm volume (XX)	
	OR	Analog output range, pO_2 (X)	1=0-200 mmHg/0-25.0 kPa
			2=0-2000 mmHg/0-250.0 kPa
	HT	Heat at site timer expiration (X)	0= off
			1= on

Miscellaneous (XX package)

Line ID: *XX*

Field ID:	PS	TCM30 state (XX). Refer to state diagram in the paragraph; "Serial Input").
	AA	Active alarms (XXXX) binary array (0= off, 1= on)
		active alarms in the following order: high pO_2, low pO_2, site timer, temperature.
	UP	Pressure unit (X), (0= kPa , 1= mmHg)
	VI	In-vivo calibration (X), (0 = disabled, 1= enabled)
	IE	Electrode current (pO_2) at calibration (XXXX) pA

The field IE is not included during calibration before start of the stability check.

Continued on next page

Serial Output, *Continued*

Category B *(continued)*

In-vivo Calibration Parameters (XV Package)

Line ID: *XV*

Field ID:			
	MO	Stored pO_2	(XXXX) mmHg/(XXX.Y) kPa
	SO	Adjusted pO_2	(XXXX) mmHg/(XXX.Y) kPa

Transmitted only if an in-vivo calibration has been performed i.e. in state 9 and 10 (also in state 11 if one complete in vivo calibration already has been carried out).

Category C

The C-lines are transmitted when an event occurs. Transmission of event lines caused by exit from the Setup or AUX programs or when an in-vivo calibration has been completed will cause one category B line to be omitted.

Alarm ON/OFF (AN or AF Package)

Transmitted when an alarm goes on or off.

Line ID: *AN* (on) or *AF* (off)

Field ID: One of the following:

HO	High limit pO_2	(XXXX) mmHg/(XXX.Y) kPa
LO	Low limit pO_2	(XXXX) mmHg/(XXX.Y) kPa
ST	Site timer	no value
TE	Temperature	(XX.Y) °C

Soft Error (ER Package)

Transmitted when a soft error occurs.

Line ID: *ER*

Field ID:			
	EN	Error code	(XX), 00 to 05

Altered State (AS Package)

Transmitted when a change of state takes place.

Line ID: *AS*

Field ID:			
	NS	new state	(XX), 01 to 11

Event Mark (EM Package)

Transmitted when the alarm-off key is pressed.

Line ID: *EM*

Field ID: AO

Continued on next page

Serial Output, *Continued*

Category C ***(continued)***

Calibration Start (CS Package)

Transmitted when a calibration is started.

Line ID: *CS*

Field ID: None

Calibration End (CE Package)

Transmitted when a calibration is completed.

Line ID: *CE*

Field ID: CO pO_2 Cal. value (XXXX) mmHg/(XXX.Y) kPa

IE electrode current (pO_2) at calibration XXXX pA

Exit From Setup Program (SU Package)

Transmitted upon exit from Setup program.

Line ID. *SU*

Field ID: Same contents as for Line XS (category B)

Exit From AUX Program

Line ID: *FT*

Field ID: Same contents as for Line XF (category B)

IN-VIVO CALIBRATION END

Transmitted when an in-vivo calibration is completed.

Line ID: *VC*

Field IC: Same contents as for Line XV (category B)

Continued on next page

Serial Output, *Continued*

Category D

The D-lines are used for Trend memory dump only. During trend memory dumps, no other lines are transmitted (except dummy lines during possible X_{OFF}). If a change of state has taken place during a trend memory dump, the corresponding line will be transmitted after the dump or if it is interrupted.

Trend Memory Data (TD Package)

Transmitted every 0.6 second during the dump when not stopped by X_{OFF}.

No decimal points are used in lines associated to trend dumps.

Line ID: *TD*

Field ID:	OA	Measured pO_2	(XXXX), 15 seconds mean value
	OB	Measured pO_2	(XXXX), 15 seconds mean value
	OC	Measured pO_2	(XXXX), 15 seconds mean value
	OD	Measured pO_2	(XXXX), 15 seconds mean value

One line corresponds to 60 seconds of measurement (includes four pO_2 values). Data are only stored in the states Measure, Prepare In-vivo Measure, and In-vivo Measure.

(XXXX) corresponds to the value in mmHg if mmHg is selected as unit, or 10 times the value in kPa if kPa is selected as unit.

Trend Memory Dump Start, Part 1 (TS Package)

Transmitted at the start of the memory dump.

Line ID: *TS*

Field ID: Same contents as for line XS (category B) with the limitations written above.

Corresponds to the state of the monitor at the starting point of the trend memory dump.

Trend Memory Dump Start, Part 2 (TB Package)

Transmitted at the end of the memory dump.

Line ID: *TB*

Field ID. Contains the fields PS and UP from the XX line, and if an in-vivo cal. has been carried out, also the fields of the XV line (category B).

Corresponds to the monitor state at the trend dump starting point.

Continued on next page

Serial Output, *Continued*

Category D ***(continued)***

Trend Memory Dump End (TE Package)

Transmitted at the end of trend memory dump.

Line ID: *TE*

Field ID: DE

Calibration Error (TR Package)

Transmitted in case of a calibration error.

Line ID: *TR*

Field ID: EN error code (XX) as follows:

00 Temperature error

01 Range error, pO_2

02 Stability error, pO_2

03 Membrane error

04 Range error, pO_2 only

06 Stability error, pO_2 only

08 Heat error

Altered State (TT Package)

Transmitted when a change of state takes place.

Line ID: *TT*

Field NS New state (XX). Refer to TCM30 state diagram in the paragraph; "Serial Input").

Calibration Start (TC Package)

Transmitted where a calibration was started.

Line ID: *TC*

Field ID: CO pO_2 calibration value (XXXX) mmHg/(XXXY) kPa

Event Mark (TA Package)

Transmitted where the alarm off key was pressed.

Line ID. *TA*

Field ID: AO

Continued on next page

Serial Output, *Continued*

Category D ***(continued)***

Exit From Setup Program (TU Package)

Transmitted upon exit from Setup program.

Line ID: *TU*

Field ID: Same contents as for line XS (category B) with the following modifications: The line includes only fields corresponding to values that were changed or reset (site timer). If no values were changed, the line is omitted.

The line does not include calibration values.

In-vivo Calibration Completion (TV Package)

Transmitted at completion of In-vivo calibration.

Line ID. *TV*

Field ID: Same contents as XV line (category B)

Serial Input

For Test Purposes only

The serial input is used for test purposes only and requires the electrode plug to be coded as one of the three possibilities below. 0 means that the pin is connected to pin 17 (ground). 1 means that the pin is **not** connected to pin.

Electrode plug	Pin 10	Pin 16	Pin 18
TC Electrode Simulator	0	1	1
pO_2/pCO_2 Electrode, test mode	0	0	0
pO_2 Electrode, test mode	0	0	1

The input data are ASCII characters (numerals 0 to 9). All other characters are ignored. The numerals are interpreted as key activities as set out below:

0	Not used (ignored)
1	CAL
2	SET
3	▲
4	▼
5	▲▼
6	Not used (ignored)
7	Electrode holder microswitch
8	Electrode plug
9	Alarm off key

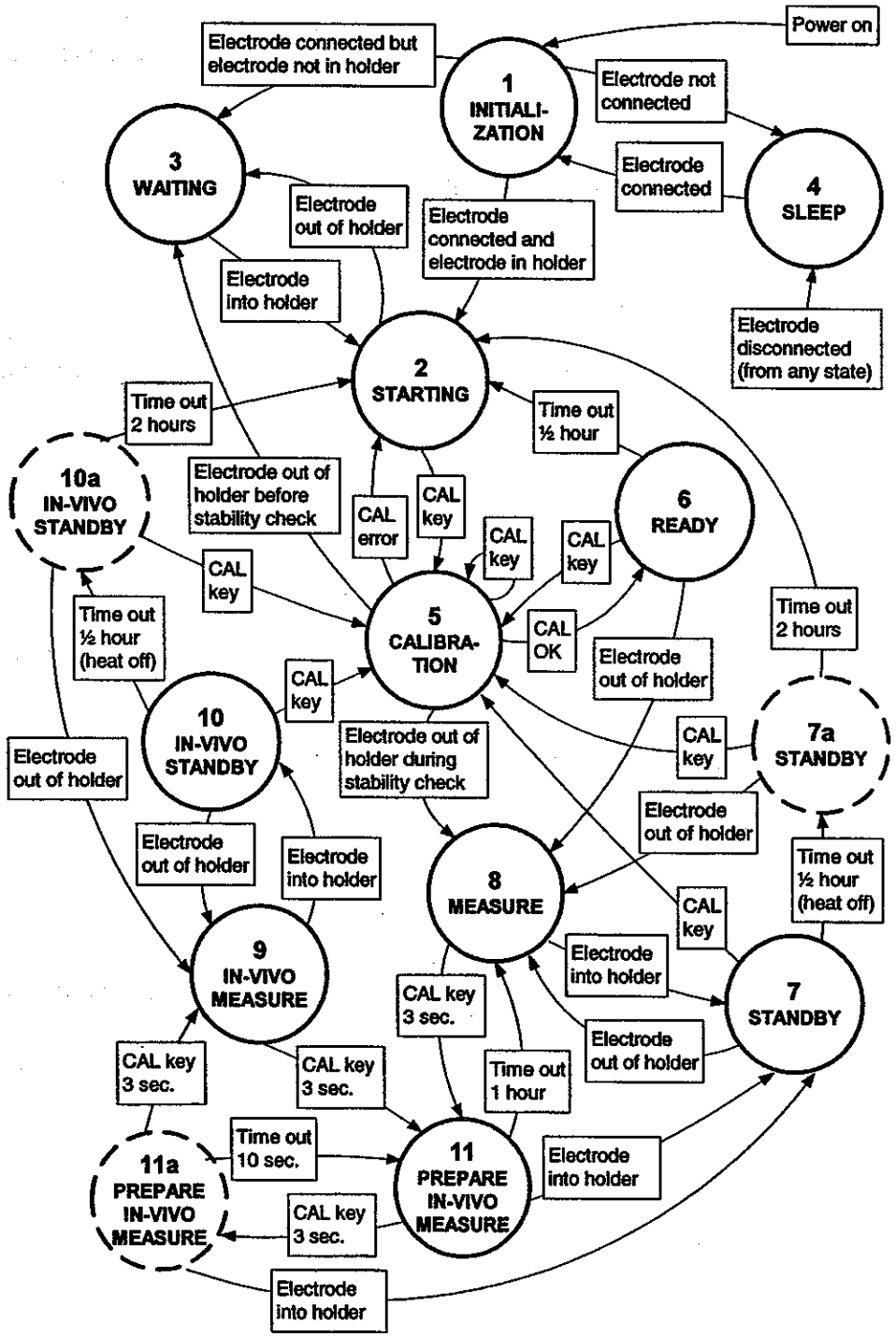
At 7 and 8, the condition change between activated and non-activated, electrode plug in and electrode plug out, respectively.

Monitor State Diagram

Introduction

The diagram shows which states the monitor enter into depending on timing and user actions.

State Diagram



4. TCC3

TCC3

Introduction

This chapter gives detailed information about the function and servicing of the TCC3 Calibration Unit.

Contents

This chapter contains the following topics.

Topic	See Page
General Information	2
Test Procedures	6
Dismantling and Replacement	9
Spare Parts	12
Circuits Description	15

General Information

Overview

Introduction This section gives some general information about the TCC3.

Contents This section contains the following topics.

Topic	See Page
General Information	3

General Information

Introduction

The TCC3 supplies the calibration gas for the TCM3 and TCM30. It is battery driven and consists of a Gas Inlet Module including a flow regulator, and a manometer indicating the pressure in the gas cylinder.

A microcomputer controls the bi-stable magnetic valve and supervises the battery condition.

The circuit is designed to switch off the gas supply automatically if the user forgets to do so after a calibration.

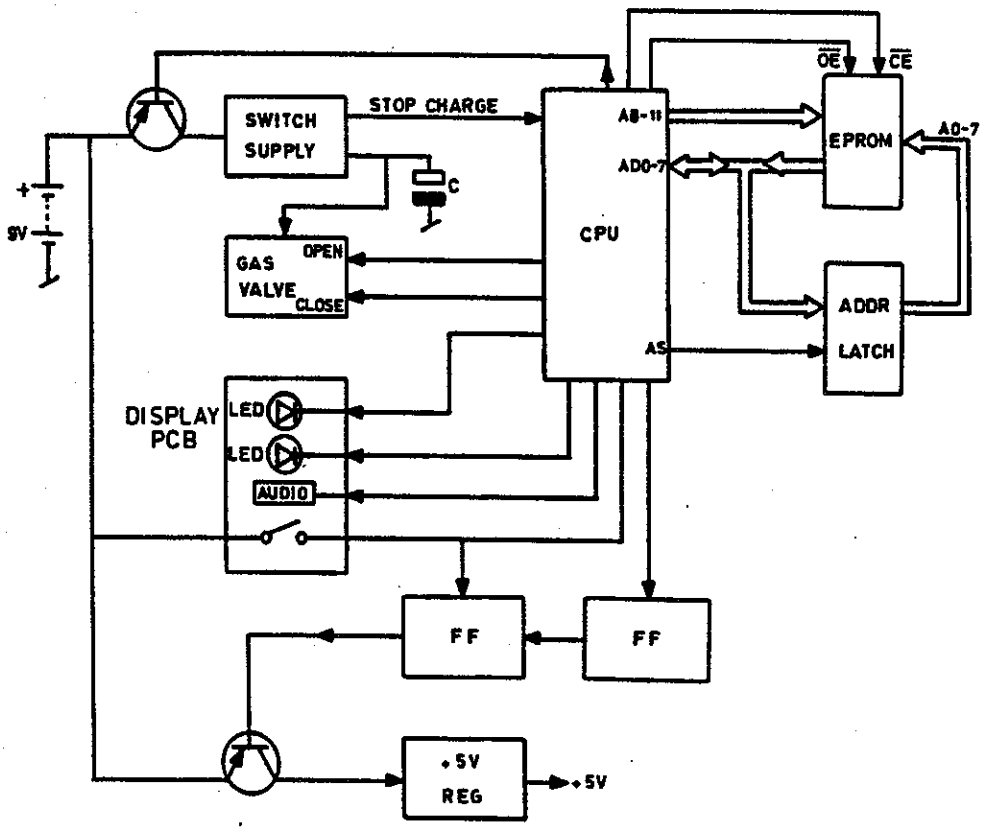
The condition of the batteries is determined by their ability to charge a capacitor, denoted C.

If the charging time exceeds a certain value, the user is informed via the front panel that the batteries should be changed. However, the circuit does carry out the opening of the valve.

If the battery condition is so bad that opening and closing the valve becomes uncertain, the circuit will not open the valve and informs the user that the batteries must be changed.

The typical lifetime for a set of alkaline batteries is about 14 months.

The Display PCB includes two LEDs, an acoustic alarm and a switch.



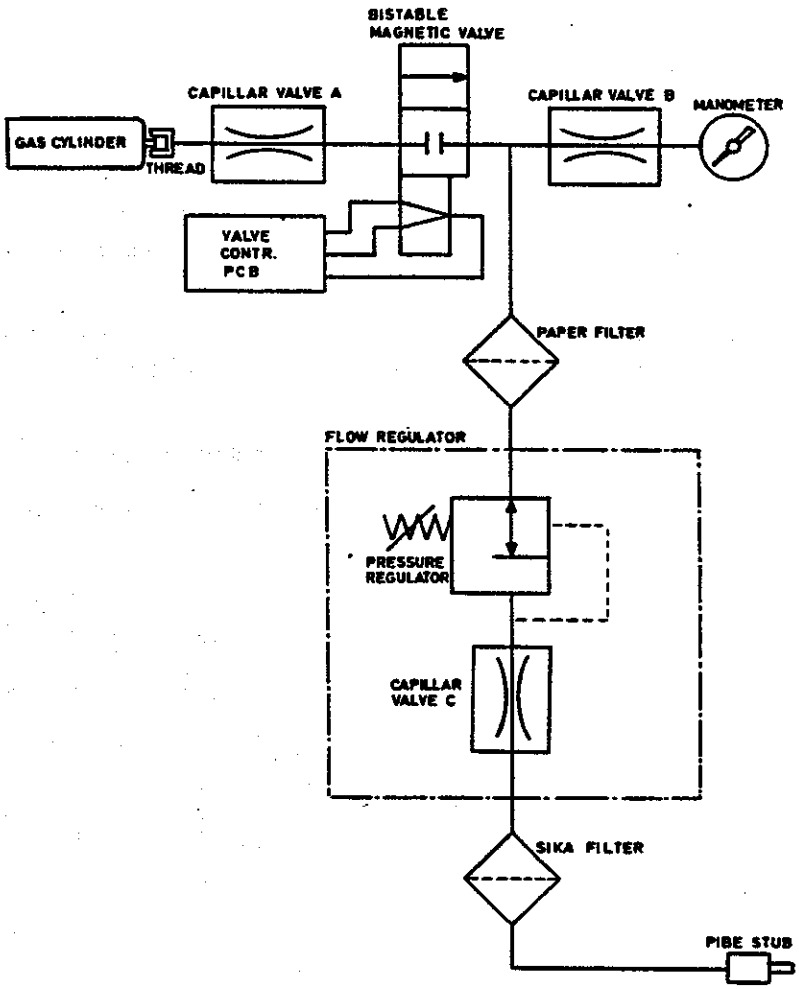
Continued on next page

General Information, *Continued*

Gas Inlet Module

The gas pressure in the cylinder is approximately 15 bars, and the flow regulator is factory adjusted to a gas flow of 8 mL/min.

The gas composition is 5% CO_2, 20.9% O_2 and 74.1% N_2.



The capillary valve, A, protects the pressure regulator and the manometer against abrupt pressure increases in case the magnetic valve is open when a new gas cylinder is mounted.

The capillary valve, B, protects the manometer and limits the diffusion between the atmospheric air in the manometer and the calibration gas.

The capillary valve, C, decreases the gas flow to 8 mL/min.

The paper filter protects the pressure regulator against impurities.

The sika filter protects the pressure regulator against impurities from the surroundings via the pipe.

Continued on next page

General Information, *Continued*

Specifications

Pressure of gas source:	Max. 20 bar (2000 kPa, 290 psi)
Gas Outflow:	8.0 ± 2.0 mL/min.
Automatic Shut Off:	May be set to 5, 8, 10, 12, 15, 20 or 50 minutes.
Dimensions	Height (cm) 8
	Width (cm) 12
	Depth (cm) 23 (excl. gas cylinder)
	Weight (kg) 1.8 (excl. gas cylinder)

Test Procedures

Overview

Introduction

This Section includes performance checks for the electrical as well as the mechanical part of the TCC3.

The Valve Control PCB software includes a test programme for a performance check of the electrical part of the TCC3.

For the Valve Control PCB check, a variable power supply 0 - 9 VDC, 0.5 A, is necessary.

For the flow regulator, a 20 mL syringe is necessary.

Contents

This section contains the following topics.

Topic	See Page
Performance Check of Valve Control	7
Performance Check of Flow Regulator	8

Performance Check of Valve Control

Procedure

This procedure checks the performance of the valve control circuit.

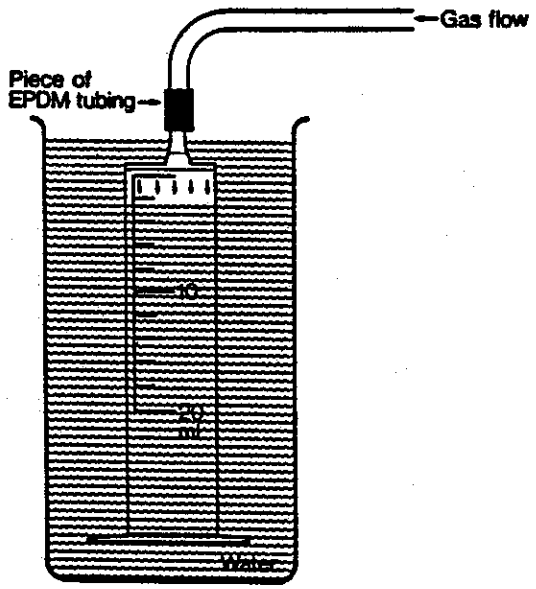
Step	Action
1.	Dismount the Valve Control PCB and remove the berg straps.
2.	Supply the TCC3 from the variable power supply and adjust the voltage to 9 volts.
3.	Press the front panel key and check that the green LED is activated. If the red LED is activated, the Valve Control PCB is probably defective and should be changed.
4.	Press the key again and check that the valve is opened (the manometer displays the gas cylinder pressure) and that the green LED starts flashing. Check that the valve closes after 30 seconds and that the green LED stops flashing.
5.	Reduce the supply voltage to 6.0 volts. (Tolerance ± 0.7 V)
6.	Press the front panel key and check that the green LED is activated. If the red LED is activated, the Valve Control PCB is probably defective and should be changed.
7.	Press the key again and check that the valve opens and that the acoustic alarm is activated. Check that the red LED flashes 4 times and that hereafter the green LED starts to flash. Check that the valve closes after 30 seconds and that the green LED stops flashing.
8.	Reduce the supply voltage to 4.9 volts.
9.	Press the front panel key and check that the green LED is activated. If the red LED is activated, the Valve Control PCB is probably defective and should be changed.
10.	Press the key again and check that the acoustic alarm is activated and that the red LED lights for 3 seconds.
11.	Disconnect the power supply, reconnect the internal battery cable and remount the berg straps in accordance with the selected gas dosage time.

Performance Check of Flow Regulator

Procedure

This procedure checks the performance of the flow regulator.

Step	Action
1.	Remove the piston of a 20 mL syringe. Immerse the syringe into a glass beaker filled with water, so that the syringe is filled. See the figure below.
2.	Connect the silicone rubber tube from the TCC3 to the tip of the syringe as illustrated.
3.	Open for the gas flow from the TCC3 and check that the syringe empties with 8 ± 2 mL per minute.



Dismantling and Replacement

Overview

Introduction

This section details the procedures for dismantling the TCC3 and replacing parts.

Contents

This section contains the following topics.

Topic	See Page
Procedures for Dismantling and Replacements	10

Procedures for Dismantling and Replacements

Introduction

For the dismantling and replacements of the parts in TCC3, a pozidrive # 1 screwdriver is necessary.

The numbers in brackets refer to the exploded view in the spare part section.

Battery Change

Unscrew the black battery cover (25) and change the 6 alkaline batteries (28).

Note that all six batteries must be changed at a time.

Ensure that the batteries are orientated correctly as shown on the labels on the battery tubes (27).

Cabinet

Step	Action
1.	Remove the battery cover (25) and the rear plate (21).
2.	Unscrew the two bottom screws (22) and separate the cabinet from the rest of the TCC3. The cover (29) and the bottom plate (30) are assembled by eight screws (22) mounted under the four self-adhesive rubber feet (33).

Battery Tubes (27)

Loosen the four side plate screws (14) and draw out the tubes (27).

Ensure that they are remounted correctly to ensure the correct orientation of the battery labels.

Valve Control PCB (15)

Step	Action
1.	Remove the side plate (18), unscrew the screen (17) and disconnect the three cable connectors (1), (19), and (20).
2.	Unscrew the four screws that fasten the PCB (15) to the side plate (18) and remove the two hexagonal stand-offs (16).

Front Panel (4)

Step	Action
1.	Unscrew the four screws (13) and disconnect the 7 pole cable connector (19).
2.	Unscrew the four screws (9) and separate the Display PCB (6) and the Front Panel (4).

Ensure that the cables are not clamped when the panel is remounted.

Continued on next page

Procedures for Dismantling and Replacements, *Continued*

Gas Inlet Module (1)

Step	Action
1.	Unscrew the four screws that secure the module to the aluminum chassis (11) around the gas manifold.
2.	Dismount the 3 pole cable connector from the Valve Control PCB (15) and draw carefully the cable through the chassis slot.

Ensure that the cables are not clamped when the Module is remounted.

Spare Parts

Overview

Introduction

This section lists the spare parts available for servicing the. The spare parts list specifies to which extend the monitors may be serviced as only the spare parts listed may be replaced.

Contents

This section contains the following topics.

Topic	See Page
Available Spare Parts	13

Available Spare Parts

Introduction

All spare parts available for the TCC3 are listed in this section which also includes an exploded view to ease the identification of the parts.

When ordering spare parts include the code number and the description of the part.

Trade-in Parts

The modules marked with an * must be returned to the RADIOMETER for replacement. This is to ensure the highest possible degree of functional safety.

They will be replaced in accordance with our Trade-in arrangement for modules, with the exception of modules that have been damaged during attempted repairs.

Available Parts

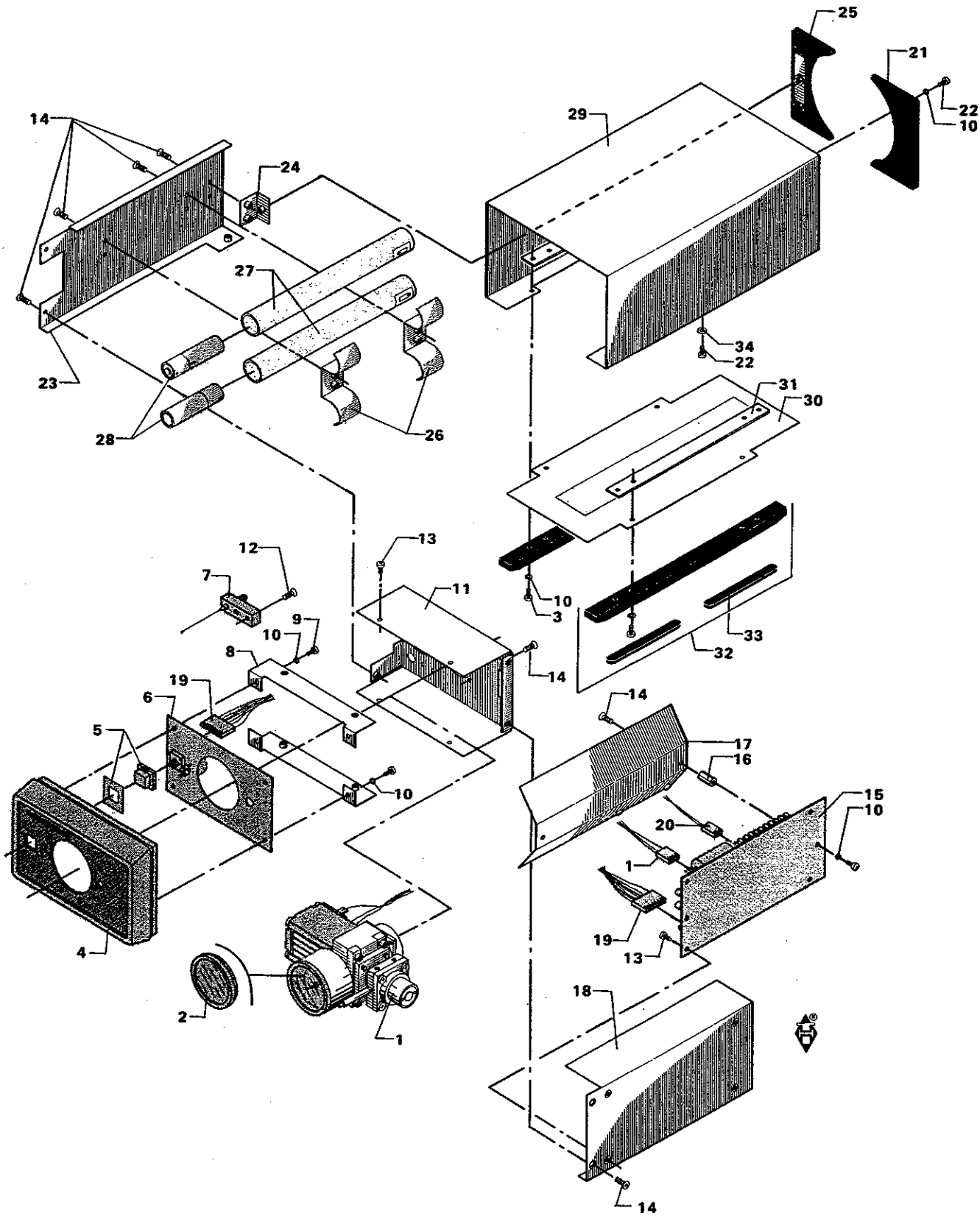
The numbers in the left column refer to the exploded view at the end of this Section.

Ref. No.	Part No.	Quantity	Description
1	927-000	1	Gas Inlet Module, complete with cable
2	927-015	1	Front glass for Manometer
3	008-308	8	Screw, M3 x 8
4	927-004	1	Front Panel, complete
5	927-014	1	Key, complete
6	901-680	1	Display PCB, complete
7	927-001	2	Battery Terminal, complete
8	887-427	2	Bracket for Display PCB
9	008-310	4	Screw, M3 x 10
10	046-901	16	Spring Washer M3
11	885-706	1	Chassis for Gas Inlet Module
12	009-308	4	Screw, M3 x 8, countersunk
13	008-306	8	Screw, M3 x 6
14	009-306	16	Screw, M3 x 6, countersunk
15	901-649	1	* Valve Control PCB, complete
16	037-312	2	Stand-off
17	885-709	1	Screen
18	927-005	1	Right side plate, complete
19	927-006	1	Cable, 7-pole, complete

Continued on next page

Available Spare Parts, *Continued*

Available Parts *(continued)*	Ref. No.	Part No.	Quantity	Description
	20	927-016	1	Cable, 2-pole, complete
	21	886-207	1	Rear Plate
	22	008-902	4	Screw, M3 x 10, black
	23	885-708	1	Left Side plate
	24	887-428	1	Bracket for Battery Cover
	25	927-009	1	Battery Cover, complete
	26	826-242	2	Bracket for Battery Tubes
	27	927-008	1	Set of Battery Tubes, complete
	28	430-122	1	Set of Batteries. Type LR 6 (US size AA)
	29	927-007	1	Cover, complete
	30	927-002	1	Bottom Plate, complete
	31	885-704	2	Thread Plate
	32	927-003	2	Bottom Rail, complete.
	33	837-133	4	Rubber foot
	34	042-306	2	Washer



TCC3 SERVICE PARTS

Circuits Description

Overview

Introduction

This section gives detailed information as to build-up and function of the electronics. It provides the background information required for servicing the TCC3.

Contents

This section contains the following topics.

Topic	See Page
Valve Control PCB	16
Display PCB	18

Valve Control PCB

Introduction

The circuits on this PCB control the gas valve, the two LEDs and the acoustic alarm mounted on the Display PCB. It consists of a microcomputer circuit, a switching mode power supply and diverse input/output circuits.

The CPU, QD1 (MC 146805E2) is a 8 bit CMOS processor with a multiplexed bus structure. It has a very low power consumption. It contains an oscillator, 128 bytes RAM and 16 bi-directional input/output lines.

The 8 kbyte EPROM, QD2 (27C64) contains the program memory. The address latch QD3 (MM74HC373) performs the address/data de-multiplexing.

The switching power supply consists of QA1 and associated components.

The circuitry is shown on the drawing 2379-A1.

Functional Description

When the front panel key S1 is pressed, the flip flop Q4/Q5 is activated, and the circuit is supplied with +5V and V+ via Q3 and the regulator Q2.

The CPU output terminal PA7 (CHARGE) will go high activating Q7, Q6 and the switching supply. The charging of capacitor C7 then starts.

When C7 reaches 8.5 V (stop charge value) the LBD terminal of QA1 will go low and the CPU switches off Q7 and Q6 again. The charging of C7 stops.

The CPU measures the time taken for C7 to reach 8.5 V. This charging time is then taken as a measure of the battery condition.

1. Charging time less than 260 ms (battery voltage higher than 6,5 V typically). The CPU PA6 will go high opening the valve via Q9 and Q8. The green LED flashes in response to PA1 and Q12.
2. Charging time between 260 and 300 ms (battery voltage between 5.5 and 6.5 V typically). The valve is opened, and the alarm is activated via PA0 and Q14. The red LED flashes 4 times in response to PA2 and Q13. The green LED flashes. The alarm and the red LED warns the user that the batteries should be changed. However, they still contain enough energy to open and close the valve.
3. The charging time is longer than 300 ms (the battery voltage is below 5.5 V typically). The alarm is activated, the red LED lights for 3 seconds and the valve-close coil is activated to discharge C7. The alarm and the red LED inform the user that the battery condition is so bad that a successful opening/closing of the valve cannot be achieved.

Continued on next page

Valve Control PCB, *Continued*

Functional Description ***(continued)***

The valve-open time depends upon the settings of the strapping field TS1:

T3	T2	T1	Time
1	1	1	30 seconds (TEST)
1	1	0	5 minutes
1	0	1	10 "
1	0	0	20 "
0	1	1	15 "
0	1	0	12 "
0	0	1	8 "
0	0	0	50 "

0 = Berg-strap inserted.

1 = Berg-strap not inserted.

If the gas dosage time runs out, or S1 is pressed a second time (recognised by the CPU via Q1) the valve is closed and the power off terminal (PA4) goes high. This will switch off V+ and +5V via Q15/Q16 and Q4/Q5 and the circuit goes into standby.

Test Points

The PCB has the following test points:

TP 1,1 0 V

TP 1,2 Key

TP 1,3 PB3

TP 1,4 PB4

TP 1,5 PB5 (for special test purpose only)

TP 1,6 PB6

TP 1,7 PB7

TP 1,8 Reset

TP 1,9 V_{C7}

TP 1,10 Stop charge

TP 1,11 +5V

TP 1,12 V+

TP 1,13 V_{BATT}

TP 1,14 Not Connected

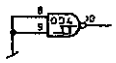
TP 1,16 Switching supply input voltage

Display PCB

Functions This PCB includes a key, a red and a green LED and an acoustic transducer.

QA 1	RC4193 NB	SWITCHMODE REGULATOR
QD 1	MC146805 E2	CPU C-MOS
QD 2	27C64	UV-EPROM
QD 3	MM74HC373	OCTAL D-LATCH
QD 4	HEF4093BP	QUAD 2 INPUT NAND SCHMITT TRIGGER
X1	1,00 MHz XTAL ± 200 Hz	910-121

Additional:



TESTPLUG TP1

GND	1	16	CHG PWR
$\overline{KEY}$	2		
PB3	3	14	NC
PB4	4	13	V BAT
PB5	5	12	V+
PB6	6	11	+5V
PB7	7	10	STOP CHG
$\overline{RESET}$	8	9	V C7

ADD 100 TO ALL SYMBOLS NUMBERS
901-680 DISPLAY PBC 971-271

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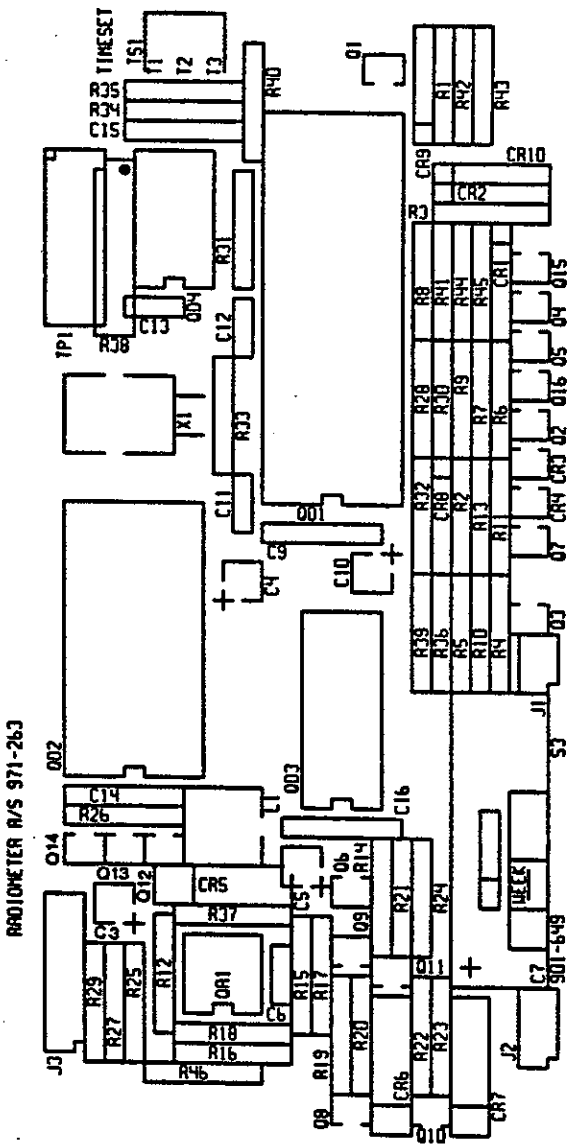
REVISIONS						
ISSUE	FROM NO.	DATE	DRAWN BY	CHECKED BY	APPR. BY	
2		25.8.97	QH			
1		Release	STD			

RADIOMETER COPENHAGEN

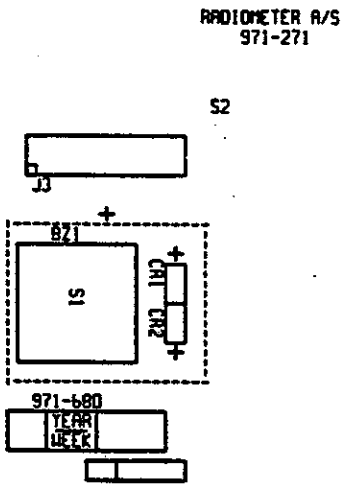
TC-Calibration Unit
000-104
TYPE TCC3
FROM NO. TO NO.

DRAWN BY US 09-12-96
CHECKED BY LSc 5-2-96
APPR. BY SCH 9-5-96

2379-A1



TCC3 Valve Control PC-Board 901-649
Component Layout



TCC3 Display PC-Board 901-680
Component Layout

5. TCR3 and REC

TCR3 and REC

Introduction

This chapter gives detailed information about the function and servicing of the recorders TCR3 and REC.

Contents

This chapter contains the following topics.

Topic	See Page
General Information, TCR3	3
Test Procedures, TCR3	7
Dismantling and Replacement, TCR3	13
Spare Parts, TCR3	17
Circuits Description, TCR3	21
General Information, REC	27
Test Procedures, REC	31
Dismantling and Replacement, REC	37
Spare Parts, REC	41
Circuits Description, REC	47

General Information, TCR3

Overview

Introduction

This section gives some general information about the TCR3 recorder.

Contents

This section contains the following topics.

Topic	See Page
General Information	4

General Information

Introduction

The TCR3 is a digital recorder for printing out data from the TCM3 (not the TCM30) on 80 mm thermo-sensitive paper.

It automatically prints out the primary parameters pCO_2 and pO_2 as curves and secondary parameters such as time, temperature, calibration information and paper speed as alpha-numerical characters.

The recorder is powered from the mains by a 12 VAC adapter.

Data transfer from the monitor to the TCR3 is performed in serial mode via the rear panel D-connectors and a multi-core cable.

This link also supplies the monitor with power.

The TCR3 exists in two versions. One for real time recordings and one for real time and/or histogram recordings.

Via a rear panel DIP switch (hidden), the recorder can be coded for 7 different languages (English, German, French, Spanish, Italian, Russian and Swedish).

Software

The TCR3 is microcomputer controlled and the software primarily takes care of the following functions:

- Thermo printer control
- Front panel LED and key control
- Reading of alpha numerical characters from the monitor

The program memory includes a test program for checkout and adjustment of the recorder.

Hardware

The thermal printer is an Olivetti 2040 20 character printer for printing curves and alfa-numerical characters on 80 mm thermo-sensitive paper.

The electronics is mounted on four PCBs.

The Printer Control PCB includes the power supply, the motor control circuit, the control circuit for the 20 position printing head and the alarm output circuit.

The Display PCB includes four LEDs and two keys.

The Connector PCB includes the necessary connectors and flat-cables for interfacing the thermal printer and the Printer Control PCB.

The Computer PCB includes the microcomputer NSC 800 with its peripherals and an 8 position DIP switch for setting some user options.

Continued on next page

General Information, *Continued*

Hardware ***(continued)***

The microcomputer "reads" the DIP switch position in connection with power-on only.

The switch is found by removing the recorders' rear plate.

Switch	Function
1	Must always be OFF
2	Not used. Position indifferent
3/4	Histogram recordings. See below
5/6/7	Language selection. See below.
8	ON: Calibration curves printed. OFF: Calibration curves not printed.

Real time/histogram selection:

Function	Switch 3	Switch 4
Real time recording only	OFF	OFF
Histogram recording only	ON	ON
Real time AND histogram recording	OFF	ON

Selection of the histogram combinations requires histogram software (TCR3-H)

Language selection:

Language	Switch 5	Switch 6	Switch 7
English	OFF	OFF	OFF
French	OFF	OFF	ON
German	OFF	ON	OFF
Italian	OFF	ON	ON
Spanish	ON	OFF	OFF
Russian	ON	OFF	ON
Swedish	ON	ON	OFF

Continued on next page

General Information, *Continued*

Specifications

Dimensions:

Height 8 cm

Width 12 cm

Depth 23 cm

Weight 1.9 kg

Paper speeds (selected via the front panel):

1 mm/min., 5 mm/min., or 10 mm/min.

Power requirements:

100/120/220/240 VAC through appropriate mains adapter.

Consumption (adapter primary): Recorder and monitor. Typically 16 VA.

Alarm output:

Open collector switch. Max. load 24V/250 mA

Test Procedures, TCR3

Overview

Introduction

This section details the procedures for testing and adjusting the TCR3. For each of the paragraphs the required tools for testing are listed.

Contents

This section contains the following topics.

Topic	See Page
Introduction	8
Test Procedures	9
Error Codes	11

Introduction

Introduction

This section describes the necessary procedure for checking and adjusting the TCR3.

It is intended that repairs to TCR3 are made only by replacing defective PCBs, which are returned to RADIOMETER for exchange.

RADIOMETER recommend a yearly preventive maintenance checkout.

Checkout and Adjustment

To carry out the checkout and adjustment procedure, the following accessories are necessary:

- 4 1/2 digit True RMS Digital Voltmeter, (the Fluke 8060A is recommended). The accuracy in the DC voltage ranges must be equal to or better than 0.05% + 2 digits.
- Adjustment tool for the trimming potentiometers.
- 5 mm wrench for adjusting the tacho disk.

The TCR3 Checkout and Adjustment procedure is based on the test software included in the TCR3 program memory.

The test program is called by switching on the TCR3 while the two front panel keys are depressed simultaneously.

The test software includes 6 program steps which are identified by the front panel LEDs.

The LED combination for each program step is shown in the left margin.

The paper feed key is used to step through the test program.

Note

It is recommended to load the mains adapter by the monitor to prevent an over-voltage to influence the checkout and adjustment procedure.

Test Procedures

Self-test

In this step a self-test of the RAM, EPROM, EEPROM, and peripherals is carried out.

Step	Action	Front Panel LEDs
1.	Switch on the recorder while the two front panel keys are depressed simultaneously. All 4 LEDs are activated.	● ▶ ▶ ▶
2.	Wait approximately 20 seconds for the self-test to finish. The test program proceeds automatically to the next step.	

Printing Pulse

This procedure is used for adjusting the printing pulse.

Step	Action	Front Panel LEDs
1.	Connect DVM+ to TP3 and DVM- to TP1. Ensure that the DVM is a TRUE RMS type.	● ▶ ▶
2.	Check that the average value of the pulse signal (DVM in the DC voltage range) is 3.30 ± 0.01 V. If outside, adjust R138 on the Printer Control PCB to 3.300 ± 0.005 V.	
3.	Press the paper feed key to proceed to the next program step.	

Motor Amplifier Feed Back

This procedure is used for adjusting the feed back to the motor amplifier.

Step	Action	Front Panel LEDs
1.	Check that the motor is running and that paper is mounted.	● ▶
2.	Connect DVM+ to TP4 and DVM- to TP1 and check that the voltage is approximately 1.30 to 1.40 V. The DVM reading is difficult as the voltage changes during the check. If outside, adjust R126 on the Printer Control PCB to approximately 1.30 V.	
3.	Press the paper feed key to proceed to the next program step.	

Continued on next page

Test Procedures, *Continued*

Automatic Motor Speed

The test program now automatically adjusts the motor speed to 5 micro lines pr. second corresponding to 400 ms between each line interrupt. When the adjustment has been finished, the necessary D/A converter data input is stored in the EEPROM, the motor stops and the stored data is printed on paper as a decimal number.

Step	Action	Front Panel LEDs
1.	Press the paper feed key to proceed to the next program step.	● ▶

Printing Voltage and Tacho Disk

This procedure is used for adjusting the printing voltage and the mechanical position of the tacho disk.

Step	Action	Front Panel LEDs
1.	Connect DVM+ to TP8 and DVM- to TP1 on the Printer Control PCB. Check that the voltage is 17.6 ± 0.4 V. If necessary, adjust R111 on the Printer Control PCB to 17.6 ± 0.4 V.	● ▶
2.	Check that the 3 lines printed on the middle of the paper are straight and regular. If necessary, loosen the tacho disk by a 5 mm wrench and adjust the disk. Fasten the tacho disk after the adjustment.	
3.	Press the paper feed key to proceed to the next program step.	

Test Printout

This procedure generates a printout including the character set and the software version.

Step	Action	Front Panel LEDs
1.	Check that the alpha numeric character set and the software version number is printed on paper.	● ▶ ▶
2.	The checkout and adjustment procedure except the self-test can be repeated by pressing the paper feed key.	

Error Codes

Error indications

The table below lists the error codes which is a combination of flashing LEDs. The table also lists the corresponding causes and corrective actions.

Error Code	Cause	Corrective Action
●	Paper run out	Mount a new paper roll
● ▶	Parallel port error	If the error code remains activated after the recorder has been switched off and on, replace the Microcomputer PCB
● ▶	Serial Port error	
● ▶ ▶	RAM error	
● ▶	EPROM error	
● ▶ ▶	EEPROM error	
● ▶ ▶	Motor error	Check the DC voltage in TP4.
● ▶ ▶ ▶		Check that the DC voltage in TP7 is < 21 V
Consecutively left to right flashing LEDs	Software error	If the error code remains activated after the recorder has been switched off and on, replace the Microcomputer PCB

Dismantling and Replacement, TCR3

Overview

Introduction

This section details the procedures for dismantling the TCR3 and replacing parts.

Contents

This section contains the following topics.

Topic	See Page
Procedures for Dismantling and Replacements	14

Procedures for Dismantling and Replacements

Introduction

To dismantle and replace the various parts of the TCR3, the following tools are necessary:

Pozidrive screwdriver, # 0

Pozidrive screwdriver, # 1

The numbers in brackets refer to the exploded view in section 4.

Cabinet (48)

Step	Action
1.	Disconnect the cables and switch off the recorder.
2.	Remove the paper lid (49), the rear plate (38) and the two bottom screws (19).
3.	Carefully draw the cabinet from the front panel (1).
4.	When replacing the cabinet, ensure that the flat-cable on the recorders' left side is not clamped.

Front Panel

Step	Action
1.	Remove the four screws attaching the fixation brackets (14) to the two aluminium chassis (21 and 31).
2.	Disconnect the PCB connector from the Printer Control PCB (18) and remove the two fixation brackets (14) by the four screws (16).
3.	Lift off the Display PCB (3) and the front part assembly (4 to 13)
4.	When replacing the entire front section (1 to 16) ensure that the 7-pole cable is not clamped.

Computer PCB

Step	Action
1.	Unscrew the four screws securing the PCB to the stand-offs (32).
2.	Unplug the flat-cable from the Printer Control PCB (18).

Printer Control PCB

Step	Action
1.	Unscrew the four screws securing the PCB to the right and left aluminium chassis (21 and 31).
2.	Unplug the cable connector (40) and the flat-cable (50) from the PCB.

Continued on next page

Procedures for Dismantling and Replacements, *Continued*

Thermal Printer Unit

Step	Action
1.	Unscrew the 4 screws securing the Connector PCB (50) to the two brackets (22).
2.	Carefully unplug the 2 flat-connectors from the connector PCB (50) and unscrew the 4 screws securing the mounting plate (26) to the left and right aluminium chassis (21 and 31).
3.	Remove the printer unit/mounting plate by lifting and turning outwards the lower edge from the paper guide (17).
4.	Separate the printer unit and the mounting plate by unscrewing the 4 screws (28).

Spare Parts, TCR3

Overview

Introduction

This section lists the spare parts available for servicing the TCR3. The spare parts list specifies to which extend the monitors may be serviced as only the spare parts listed may be replaced.

Contents

This section contains the following topics.

Topic	See Page
Available Spare Parts	18

Available Spare Parts

Introduction

All spare parts available for the TCR3 are listed in this section which also includes an exploded view to ease the identification of the parts.

When ordering spare parts include the code number and the description of the part.

Trade-in Parts

The modules marked with an * must be returned to RADIOMETER for replacement. This is to ensure the highest possible degree of patient and functional safety.

They will be replaced in accordance with our Trade-in arrangement for modules, with the exception of modules that have been damaged during attempted repairs.

Two Software Versions

As the TCR3 software exists in two versions, standard and histogram, the Computer PCB for service will be delivered without program memory, making the spare part system as flexible as possible.

The two software versions are on stock as EPROMs with the following code numbers:

- Standard version 368-394
- Histogram version 368-395

A kit for updating the standard recorder to histogram version is available under the code no. 904-682. For further details see the spare parts list page 3.

Available Parts

The numbers in the left column refer to the exploded view at the end of this Section.

Ref. No.	Part No.	Quantity		Description
1	927-020	1		Front panel, complete
2	927-025	1		Set of keys, complete
3	901-700	1	*	Display PCB, complete
4	886-217	1		Right cover plate
5	921-425	1		Writing plate
6	886-216	1		Left cover plate
7	921-426	1		Top cover plate
8	921-423	1		Paper tear-off edge
9	008-105	7		Screw, M2 x 5 mm
10	042-207	7		Washer, ø 2.2/5 x 0.3 mm

Continued on next page

Available Spare Parts, *Continued*

Available Parts *(continued)*	Ref. No.	Part No.	Quantity	Description
	11	009-105	4	Screw, M2 x 5 mm, countersunk
	12	041-148	6	Nylon washer, ø 8.7/13 x 1.6 mm
	13	885-730	2	Fixation rail
	14	887-433	2	Fixation bracket
	15	042-359	4	Washer, ø 3.5/9 x 1 mm
	16	008-312	4	Screw, M3 x 12 mm
	17	927-026	1	Paper guide, complete
	18	901-699	1	* Printer Control PCB, complete
	19	008-306	8	Screw, M3 x 6 mm
	20	009-306	15	Screw, M3 x 6 mm, countersunk
	21	885-724	1	Left aluminum chassis
	22	887-430	2	Bracket
	23	885-722	1	Paper roll housing
	24	886-219	1	Left paper pin holder
	25	886-220	1	Right paper pin holder
	26	886-218	1	Mounting plate
	27	910-164	1	Thermal printer unit
	28	008-208	4	Screw, M2,5 x 8 mm
	29	921-424	1	Paper holder
	30	984-052		Thermo sensitive paper, box with 6 rolls
	31	885-723	1	Right aluminum chassis
	32	037-315	4	Stand off
	33	901-698	1	* Computer PCB. Without EPROM
	33a	368-394	1	EPROM for Computer PCB, standard program version
	33b	368-395	1	EPROM for Computer PCB, histogram program version
	34	885-725	1	Bracket for DIN connector
	35	805-423	1	DIN connector, 5-pole

Continued on next page

Available Spare Parts, *Continued*

Available Parts *(continued)*	Ref. No.	Part No.	Quantity		Description
	36	885-729	1		Rear aluminum chassis
	37	551-173	1		On/off switch
	38a	978-516	1		Rear plate for standard version,
	38b	978-517	1		Rear plate for histogram version
	39	008-902	2		Screw, M3 x 8 mm, black
	40	927-021	2		4-pole cable with connector
	41	927-003	2		Bottom rail for TCC3/TCR3, complete
	42	837-133	4		Rubber foot for TCM3/TCC3/TCR3
	43	008-308	8		Screw, M3 x 8 mm
	44	046-901	8		Spring washer M3
	45	042-306	2		Washer, ø 3.2/7 x 0.5 mm
	46	885-705	1		Bottom plate
	47	885-731	2		Thread plate
	48	885-720	1		Cabinet
	49	921-427	1		Cover for paper roll
	50	901-701	1	*	Connector PCB, complete
		904-682			Histogram updating kit for TCR3. Consisting of eprom with histogram software (33b) and rear plate (38b)

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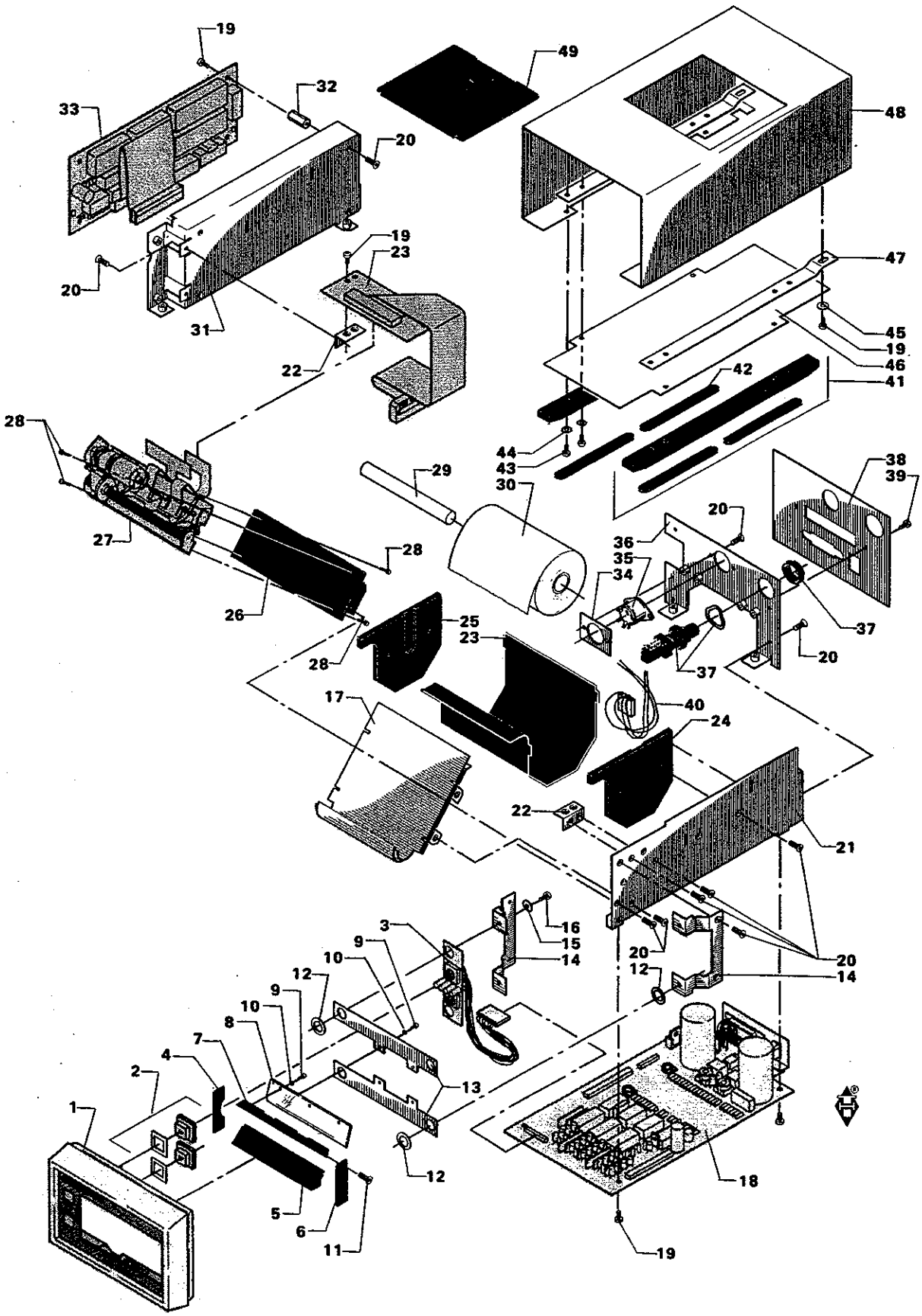


TCR3 SERVICE PARTS

Circuits Description, TCR3

Overview

Introduction

This section gives detailed information as to build-up and function of the electronics. It provides the background information required for servicing the TCR3.

Contents

This section contains the following topics.

Topic	See Page
Computer PCB	22
Printer Control PCB	24

Computer PCB

General Description

The PCB includes the front panel control circuitry, the 8 DIP switches for customer specified options and the serial interface to the TCM3 monitor.

These and the thermo printer control functions are software controlled by the 8 bit CMOS microprocessor system NSC800 with its peripherals.

The memory consists of 8 kbyte RAM and 56 kbyte program memory. Some data, such as paper speed information, are stored in an EEPROM

The circuitry is shown on the drawing 2382-A1.

Microcomputer

The microcomputer consists of the CPU (QD1), the program memory (QD6), the data memory (QD8), the EEPROM (QD7) and the address latch (QD2).

The addressing takes place via the non multiplexed address bus A8-A15, the combined address/data bus AD0-AD7 and the address latch QD2.

Data transfer between the CPU, the memories and the other peripherals also takes place via AD0-AD7.

Some of the control functions, for example the memory mapping are performed by QD4, a programmable logic device which is UV light erasable.

The equivalent diagram of QD4 is shown on the drawing 6506-A3.

The CPU oscillator is controlled by a 3.2 MHz crystal, setting the clock frequency to 1.6 MHz.

QD3 is a binary counter which produce a timing signal for the serial and parallel ports QD10 and QD11.

Continued on next page

Computer PCB, *Continued*

Input/Output

The microcomputer communicates externally with the help of the parallel port QD11 and the serial port QD10.

The input-output ports are organised as follows:

Part		Function
QD11	PA0 - PA7	All inputs. (8 DIP switches)
QD11	PB0	Interrupt output (NMI)
	PB1	Interrupt output (RSTB)
	PB2	Power check input from the Printer Control PC-Board
	PB3	Paper check input from the Printer Control PC-Board
	PB4-PB7	LED control signals for the front panel
QD11	PC0	EEPROM data input/output
	PC1	EEPROM enable output
	PC2	Clock output for the EEPROM
	PC3	Not used
	PC4	System clock output
	PC5	Trigger pulse output for the writing pulse one-shot

Part		Function
QD10	DCD	Timing input from QD3.
	CTS, DSR	Front panel key input signals
	DTR	Alarm output
	RTS	Motor on/off
	TxD	Used for factory test purposes only

The incoming data from TCM3 is checked for errors and converted to parallel for transfer to the CPU.

When incoming data is detected, an interrupt is sent to the CPU (RSTC).

Printer Control PCB

General Description

The Printer Control PCB includes the control and drive circuitry for the thermal printer, rectifier and DC regulator circuits.

Included is also a galvanic isolated circuit for the alarm output.

The circuitry is shown on the drawing 2383-A1.

Rectifier Circuit

The mains adapter AC voltage is rectified and filtered by C17, C18, L3, CR1 and C9 to a DC voltage of nominal 15 V.

Via the rear panel D-connector pin 2 and 6, the TCM3 monitor is supplied from this power source as well.

DC Regulators

The PCB includes three regulated DC sources.

QA1 is a standard liniar +5 V regulator, supplying the IC circuits of TCR3.

QA3, Q3 and associated components constitutes a step down switching regulator, supplying +5 V to the DC motor.

The writing head is supplied with +18 V formed by the step up switching regulator QA2 and associated components.

The output voltage can be adjusted by R11.

The circuit includes a high input voltage detector. With the input voltage up to 21 V the LBD voltage (pin 8) of QA2 will be low.

If the voltage exceeds 21 V, LBD goes high and the front panel LEDs start flashing, indicating excess input voltage.

DC Motor Control

The motor speed is controlled by the D/A converter QD1, the buffer QA4b, the driver QA4a and the complementary power amplifier Q4/Q5.

The motor current is measured by QA4c, the output signal of which is added to the motor drive signal to obtain a negative Z amplifier.

This is necessary for the motor to overcome varying loads at low speeds.

QA4d is a paper run-out detector. Without paper the motor consumption increases, the Paper Check signal goes low and the microprocessor stops the motor by activating Q6.

Printing Control

The control circuit for the thermal printing head is constituted by the 20 Darlington driving transistors Q7 to Q26, one for each printing element, 3 data latches QD3, QD4 and QD5 and a mono-stable multi-vibrator QD2 for adjusting (R38) the printing pulse length.

Continued on next page

Printer Control PCB, *Continued*

Line and Dot Interrupt

The dot and line strobe signals from the printers' tacho disk are regenerated and combined by the two RS flip flops QD7 to form the line interrupt and dot interrupt signals.

Alarm

The opto-coupler QA5 and transistor Q27 form a galvanic isolated alarm output circuit. Max. power requirement to the external switching system is 24 V, 250 mA.

Test Points

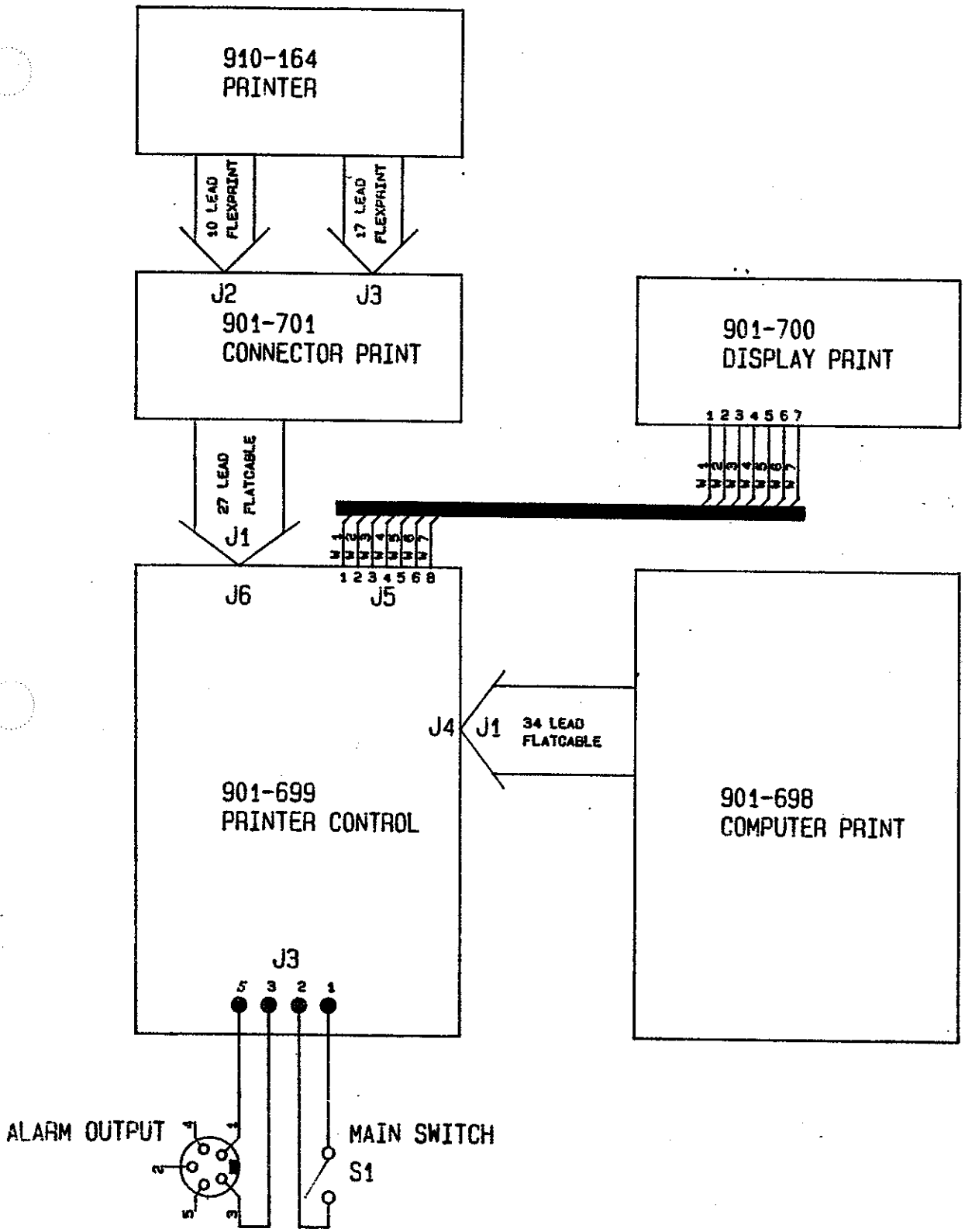
The PCB includes the following test points.

Test Point	Function
TP1	Ground
TP3	Printing pulse
TP4	Motor feed back signal
TP5	+5 V supply for motor
TP6	+5 V general
TP7	Rectifier voltage
TP8	Printing head voltage

Thermal Printer PU2040

The Olivetti PU2040 thermal printer consists of a DC motor, a printing head with 20 thermal resistor components, a mechanical cam system for horizontal movement of the printing head and a tacho disk delivering dot and line strobe signals for the printer electronic control system.

Each of the 20 thermal printing components covers 14 horizontal dots. This gives a total resolution of 280 dots pr. line.



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REVISIONS					
issue	from no.	date	drawn by	checked by	appr. by

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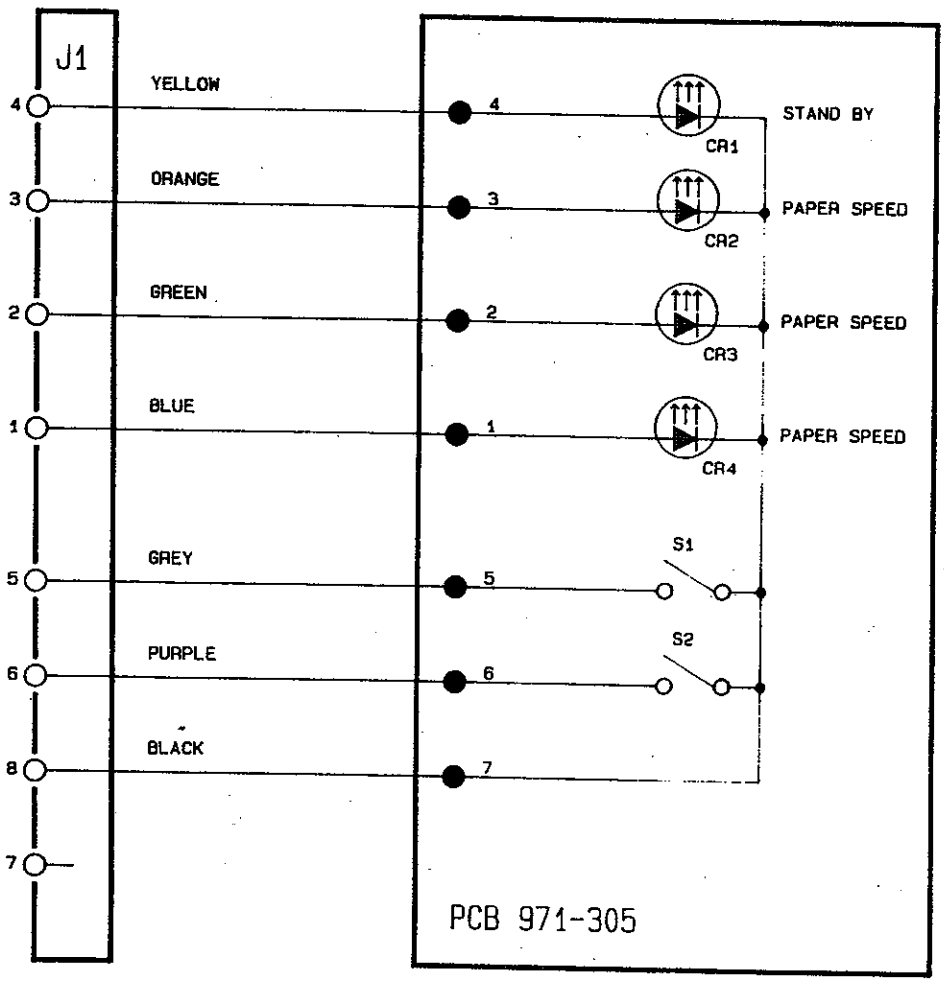
DRAWN	TMo	86-06-26
CHECKED	HC1	86-09-08
APPROVED	SCK	86-09-08

TCR3
INTERCONNECTION DIAGRAM
type 000-105
from no. to no.

6508-A3



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REVISIONS					
3		25.8.94	OH		
2		87/02/20	OH		
1		86/10/30	OH		
issue	from no.	date	drawn by	checked by	appr. by

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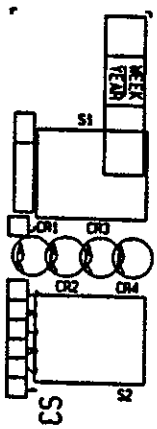
DISPLAY PCB ASSEMBLY
901-700 (908-385)

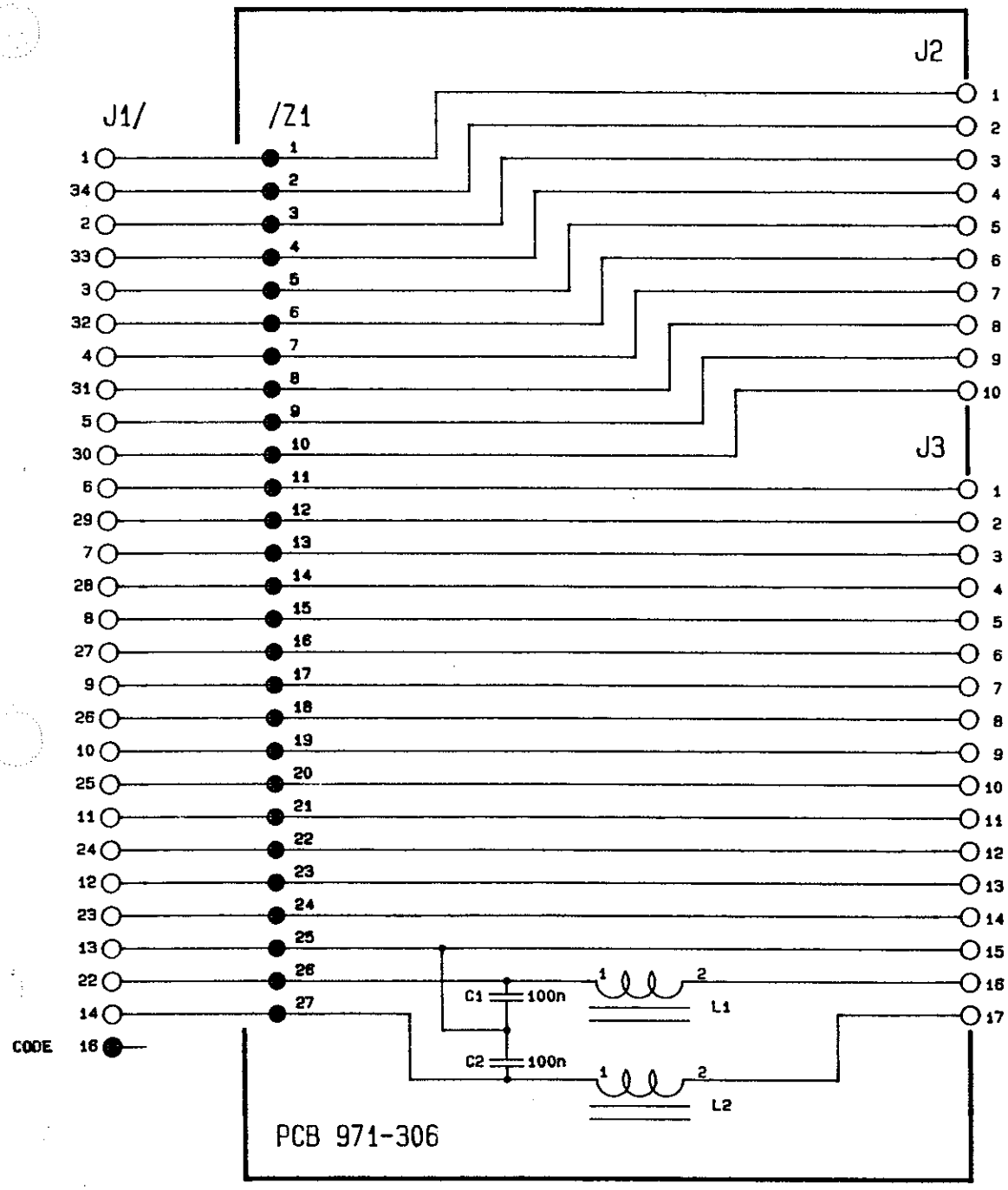
type REC3
from no. to no.

DRAWN	TMo	86-06-03
CHECKED	PB	86-06-27
APPROVED	SC	86-06-27

6427-A3



TCR3/REC Display PC-Board 901-700
Component layout



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REVISIONS

issue	from no.	date	drawn by	checked by	appr. by
2		25.8.94	OH		RV
1	901-701	26.10.06	TMO	FAK	

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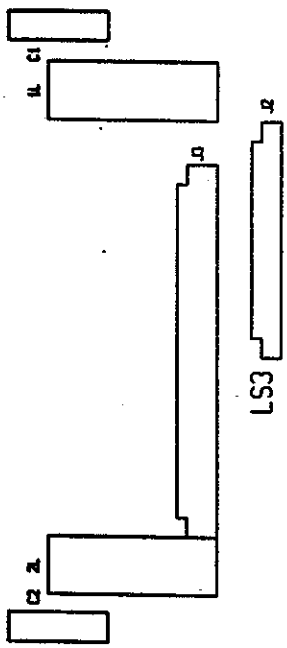
CONNECTOR PCB ASSEMBLY
901-7..., 9..-744

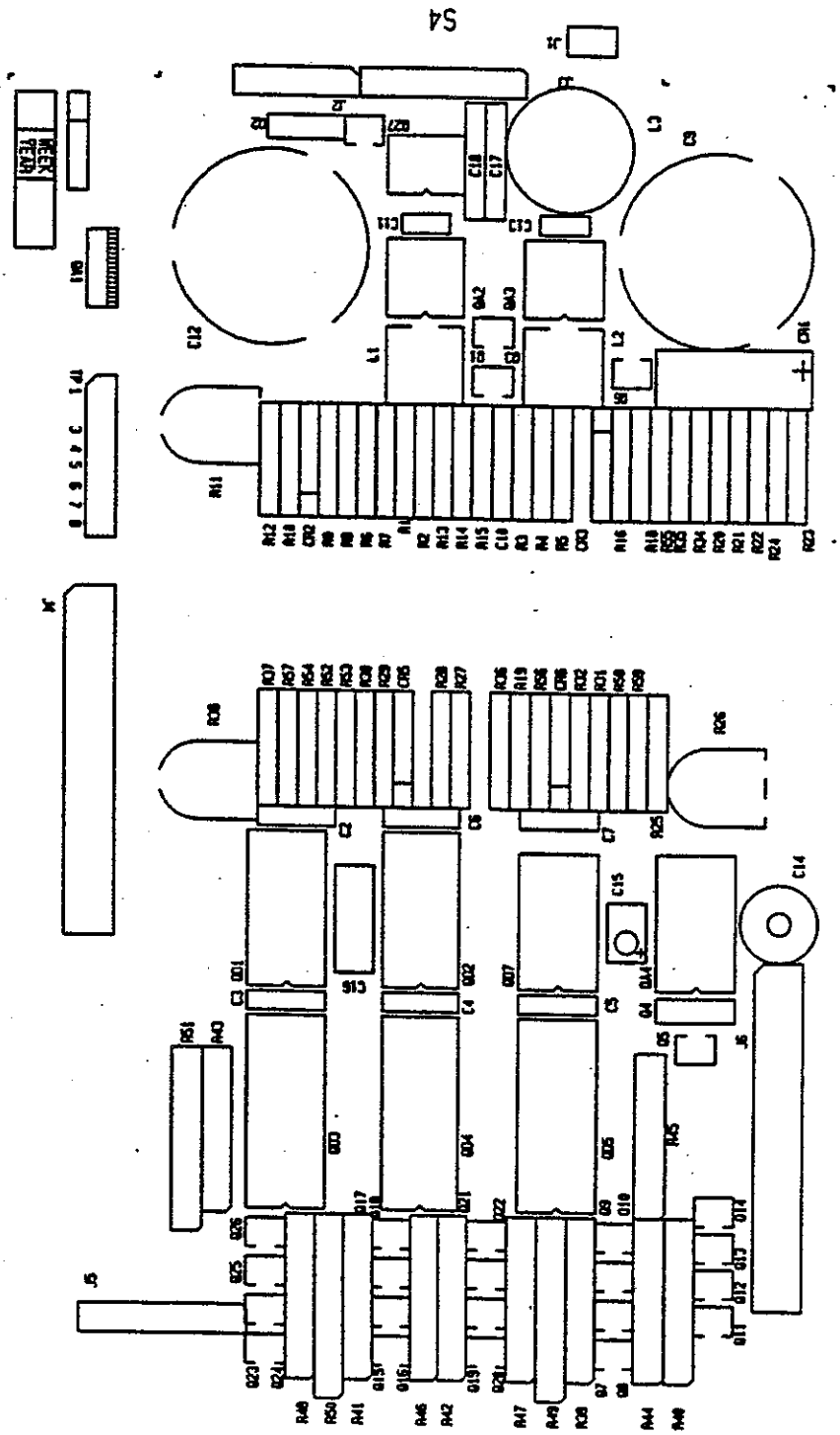
type TCR3, REC3
from no. to no.

DRAWN	TMo	86-10-08
CHECKED	MH	8.9.86
APPROVED	SLK	8.9.86

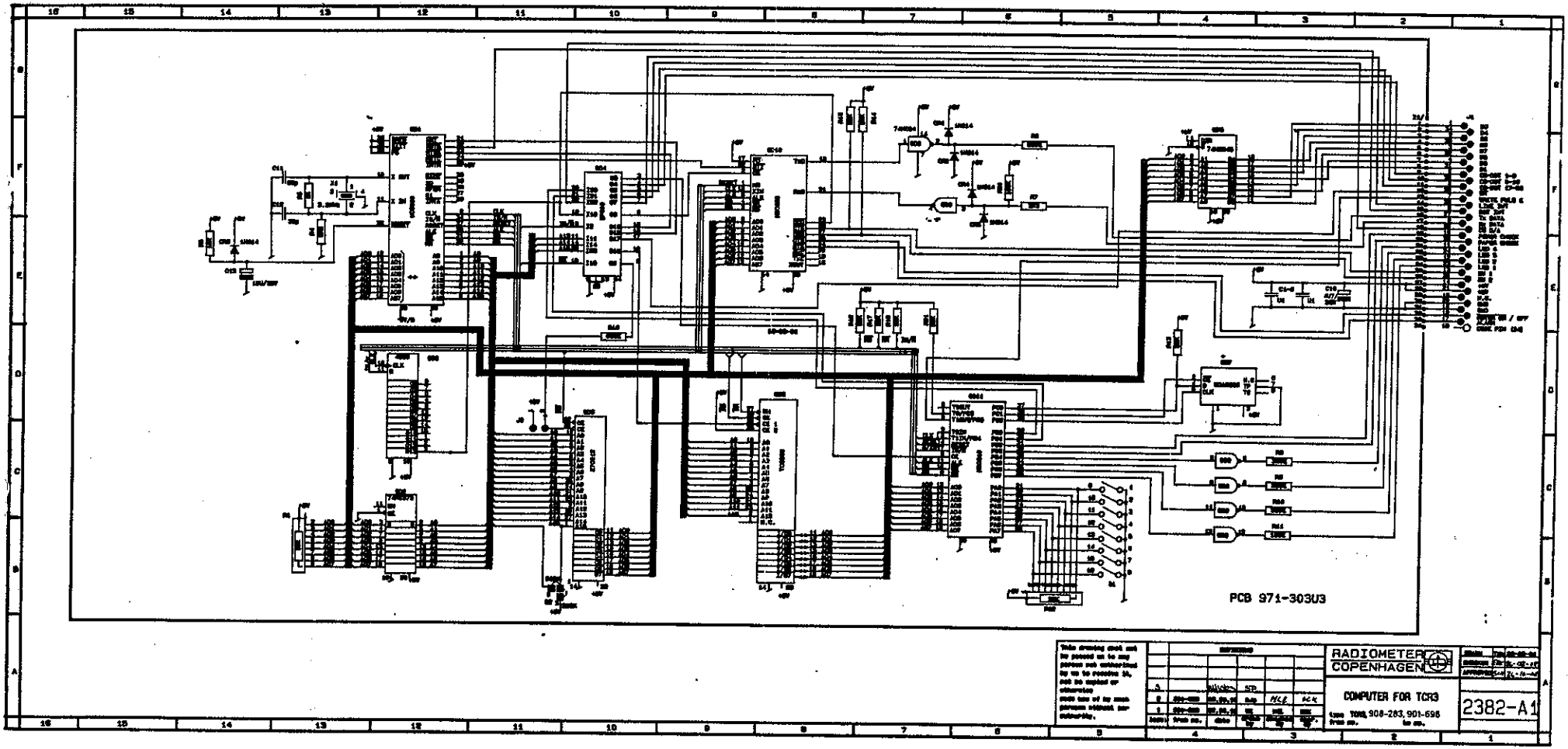
6428-A3



TCR3/REC Connector PC-Board 901-701
Component layout



TCR3 Printer Control PC-Board 901-699
Component layout



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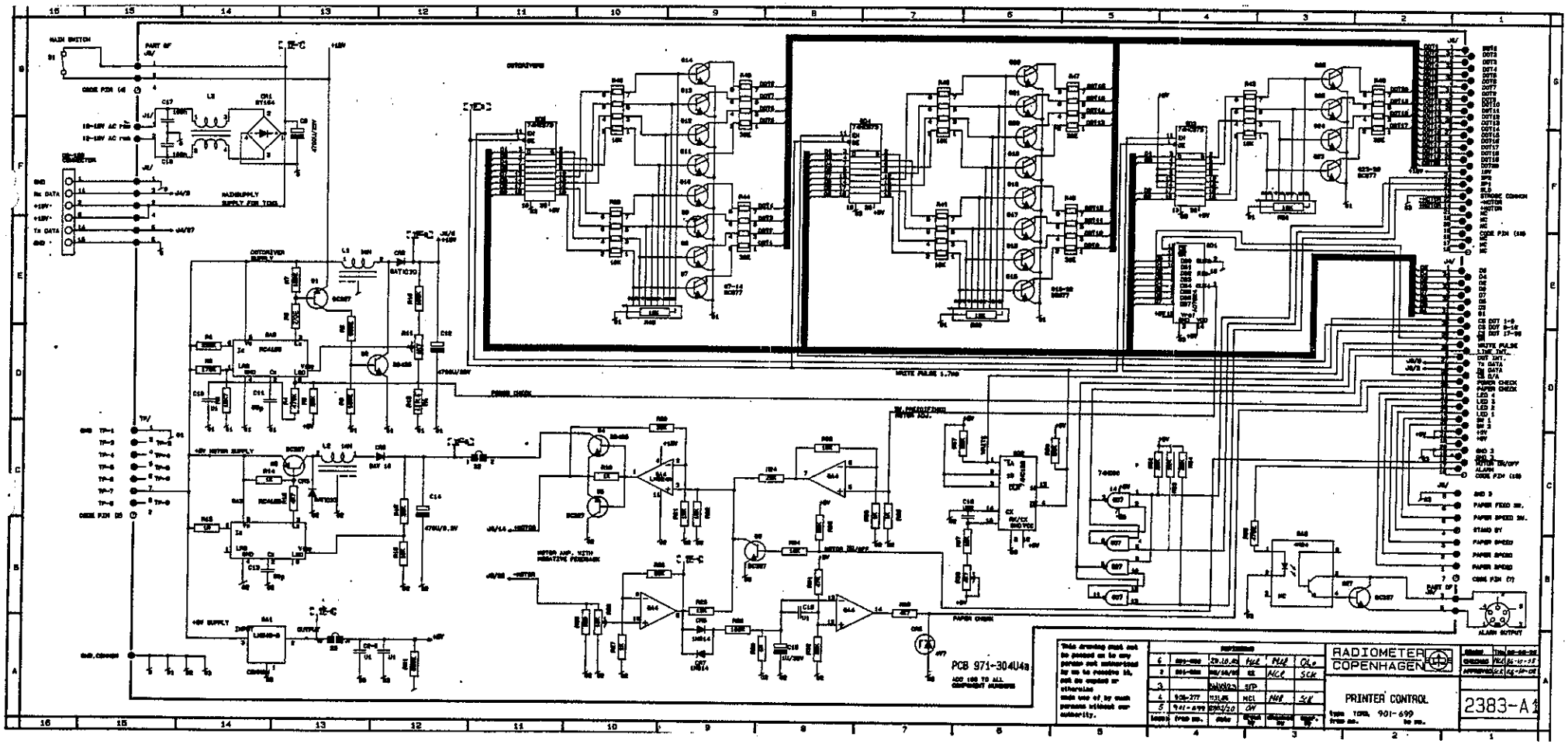
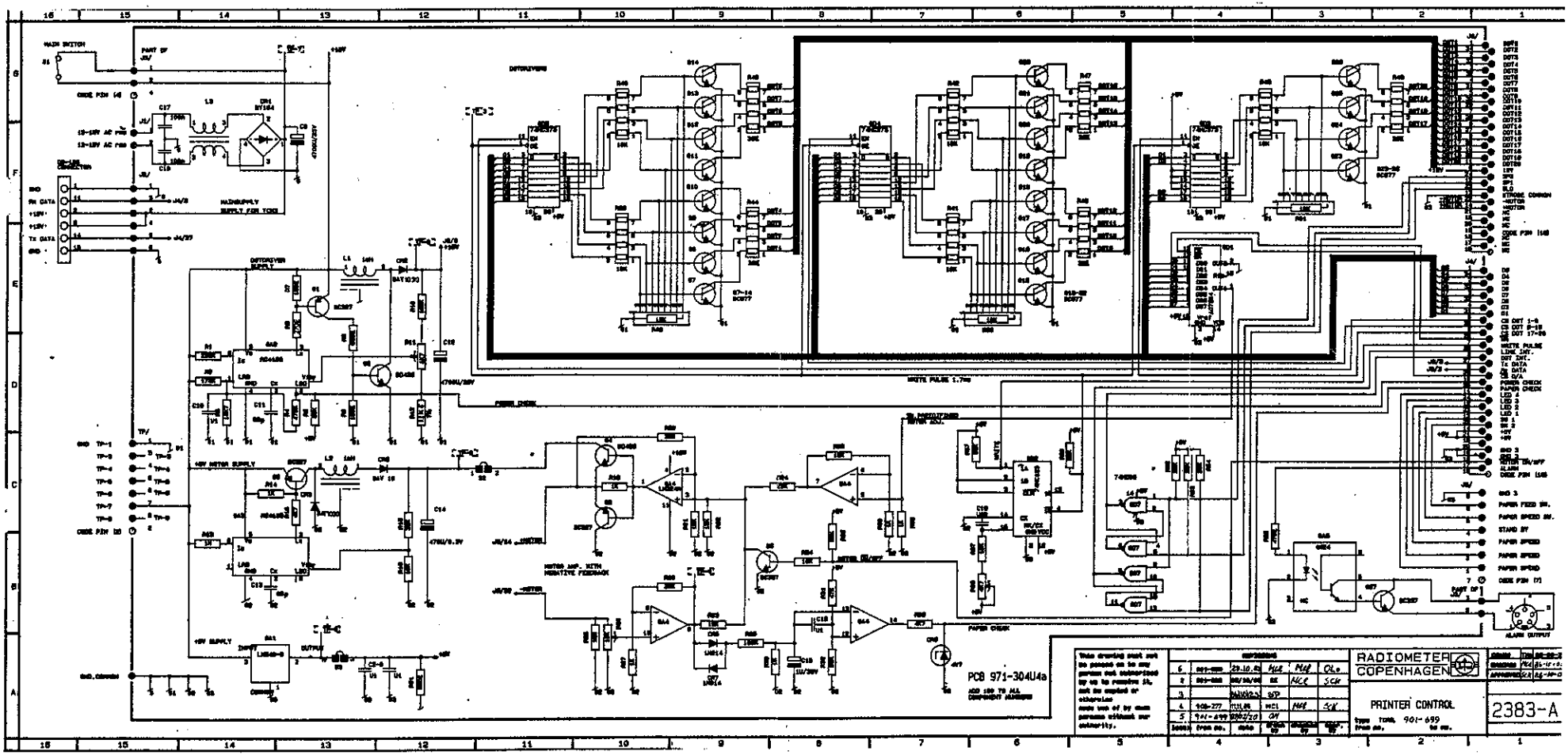
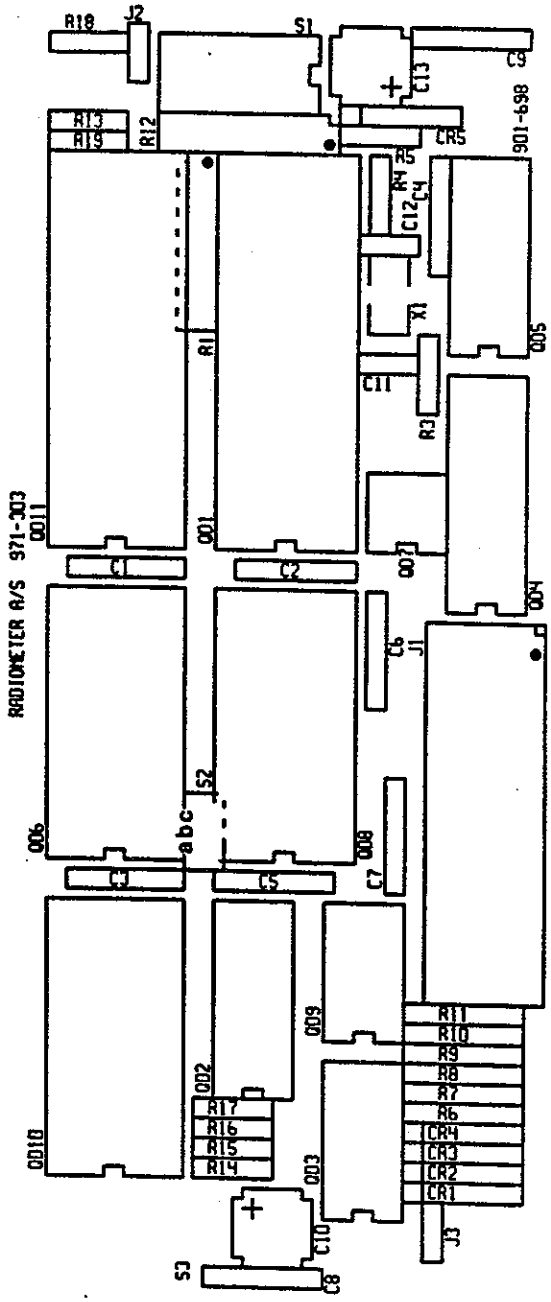
COMPUTER FOR TCR3

type TCR3, 908-283, 901-696 from no.

2382-A1


RADIOMETER COPENHAGEN
PRINTER CONTROL
2383-A1
PCB 971-304U4a


RADIOMETER COPENHAGEN
PRINTER CONTROL
2383-A
PCB 971-304U4a



TCR3 Microcomputer PC-Board 901-698
Component layout